CONSOLIDATING CONTROL:
Plant Variety Rights, Genes and Seeds

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An article in this journal nearly two decades ago predicted that Plant Variety Rights (PVR) legislation would be a leverage point for agribusiness interests to consolidate control of the Australian agricultural sector (McQueen, 1980). Today, twelve years post-PVR legislation being introduced, there is good evidence to support McQueen's prediction. Yet, it is also evident that PVR was introduced during a period where a greater restructuring was occurring due to the biotechnology revolution and globalisation. Accordingly, it is difficult to accurately define the role of PVR by itself as a leverage point. The more realistic situation is that it was part of a range of leverage points for agribusiness interests to consolidate control, albeit a significant one.

In exploring this complex ground, this article first introduces McQueen's predictions and the differing perspectives about PVR. It then looks at the broader context, including corporate seed technology strategy. This provides the platform to explore the Australian history of PVR, seed and plant breeding industry concentration trends, and PVR registration trends. Some general conclusions are then drawn.

Before going further it is appropriate to define the scope of this article more fully. McQueen (1980) also drew attention to the relevance of analysing the issues of PVR according to various Marxist theories of the use of the law in the context of a specific social formation. For example, he reflected "the law as a tool – mechanical or ideological – in the hands of powerful interest groups must be incorporated into a broader understanding of the transformation in the nature of capitalism and the role law has played and does play in these transformations" (McQueen,

1980:59). However, he did not attempt a detailed analysis of this area, and while this article touches upon this aspect it does not seek to specifically address it. Rather, to reiterate, its interest is to explore the more general role of, and impact of, PVR on corporate restructuring processes with regard to the Australian seeds industry and public sector breeding institutions.

In addition, some current debates concerning Plant Breeder's Rights (PBR) are not included in this article although they indeed provide material for complementary research. These include farmers' and indigenous peoples' rights (see *Biotechnology and Development Monitor*, 1998); and recent 'biopiracy' charges laid by the Canada-based Rural Advancement Foundation International and the Australian Heritage Seeds Curator's Association that at least 118 PBR claims in Australia may be illegitimate (see Hankin, 1998; RAFI, 1999a).

Plant Variety and Breeders Rights: Differing Perspectives

The debate over PVR – more recently redefined (in Australia) as Plant Breeders Rights (PBR) – began in 1971. It became significant in 1980 at the time of McQueen's article, was enacted as legislation in 1987, and has been well documented (for example, McQueen, 1980; Ockwell, 1982; Edwards, 1985; *Search*, 1985; Senate Standing Committee on Rural and Regional Affairs, 1994; Hancock 1998). Briefly, PV-R provides legal protection for new plant varieties developed by selective breeding, and, more recently, by modem biotechnology (or genetic engineering).(1) More exactly, PVR is an extension of the ownership-of-invention principle which underlies patent and copyright legislation, but 'lit differs from patent rights in that the right is only conferred on the end product and not on the process by which it has been produced" (Australia, Senate Standing Committee for Natural Resources 1984, cited

in Search, 1985:291). In short, the exclusive commercial rights extended under PVR (or PBR which is used interchangeably with PVR throughout this article) permit plant breeders to control the use and availability of a specific plant variety, and to levy and collect a reward in the form of royalties.

Another view that would tend to support McQueen's views is that PVR allows the extraction of increased surplus from the farm sector (Lawrence, 1988:26). How was this to be done, according to McQueen? First, McQueen (1980:59) argued, "the [pending] introduction of [PVR] legislation creates the conditions for a preferential market for patented seeds". This would, in turn, restrict the seeds which would be sold, grown or given away. Second, this would then facilitate conditions for highly concentrated control of the Australian seed market by international fuel:

> The pattern of acquisition is clear. International firms have been unwilling to integrate their operations so as to incorporate plant breeding unless they operate under the protection of PVR legislation ... The upshot ... has been that companies who a decade ago had no interest in the seed industry at all now control a large portion of the world's seed market (McQueen, 1980:60).

With this condition satisfied in Australia, an alignment of Australian public sector plant breeding to international corporate preferences would occur, with an attendant adoption of the technologies controlled by the firms acquiring control of the seed industry. In turn, McQueen (1980:62) surmised, this would lead to "a situation where mechanisation and chemically dependent crops are not presented to the farmer as an alternative, but rather as an imperative". In short, McQueen (1980:63) argued that PVR would help create a dependence "upon large agribusiness, not only for markets and inputs, but also for seeds".

Such arguments, it should be noted ' were drawn largely from the overseas experience of PVR, especially that of the USA where PBR had been introduced in 1970, and in Britain in 1980. The popular critical arguments of McQueen's day about the US experience were later confirmed by rural sociologist Jack Kloppenburg's study, published in 1988. It found that PBR had indeed led to a concentration of seed sales

by international agribusiness firms, a subsequent interlocking of public plant breeding to the technologies of these firms, that it facilitated non-competitive pricing, and constrained the free exchange of germplasm (see also Flitner, 1998). In addition, while the number of varieties had greatly increased under the impact of PBR, most were found to be only cosmetic changes for the main purpose of product differentiation. A focus on the most potentially profitable species had also contributed to genetic uniformity. Finally, Kloppenburg (1988) found that PBR was not an isolated event but the outcome of a process involving the more complete takeover of plant breeding by private industry.

McQueen's arguments also echoed the sentiments of local critics of PVR, especially those concerning the downgrading of public plant-breeding research and the control of food production by multinational petrochemical companies (see *Search*, 1985). Strongly opposed to PVR was the Plant Diversity Protection Committee (PDPC) – Australian public interest group formed in 1980 – which argued that PVR was unnecessary because overseas seed and plant material was always readily available to Australian growers (PDPC, 1985:3). Moreover, the Senate Property Advisory Committee's inquiry into the Australian industrial patent system had concluded in 1982 "that patenting was ineffective in Australia in encouraging innovation" and had advised against any extension of patent-type proprietary rights to new categories including plant varieties *(Search*, 1985:293). The real result, the critics argued, might be a shrinkage in the diversity of plant varieties which would be facilitated by cosmetic rather than substantial changes to plant varieties under the impact of PVR. The latter concern was pointed up by the then Principal Plant Breeder in the Western Australian Department of Agriculture (cited in Childs, 1982:2), and his Department had also expressed reservations about the value of plant patenting for field crops and pasture plants *(Search*, 1980:293). Finally, the critics argued, PVR would result in increased seed costs.

Conversely, most of the Australian seed and nursery trade and horticultural industry groups, as well as the federal Department of Primary Industries and both the New South Wales and Victorian Departments of Agriculture, supported the pro-PVR position. From this perspective, PVR would stimulate private investment in plant breeding

through improved profit expectations, through improved access to superior overseas varieties, and by giving protection for the substantial investments required in plant breeding (Ockwell, 1982, *Search*, 1985:293; Australia, Department of Primary Industry, nd). This, in turn, would lead to a greater number of superior and more genetically diverse varieties of seeds, which would be in the public interest. As such, PVR would not facilitate genetic resource erosion; any crop uniformity occurring would be coincidental and simply be a characteristic of modem farming and market demand. In addition, PVR would not facilitate takeovers of Australian seed companies-if they occurred it would be the result of common business activity. Nor would PVR disadvantage public sector plant breeding programmes. Indeed, the' evidence from other countries, the proponents argued, was that "the opposite situation [prevailed] as the licensing provisions of the legislation provide[d] a ready means of obtaining additional funds for further plant breeding" (see Edwards, 1985:297). Not to adopt a PVR scheme would also be out of line with countries overseas and would adversely affect reciprocity agreements for exchange of genetic material or release of new varieties. An Australian Senate Standing Committee for Natural Resources' investigation into PVR in 1984 supported these arguments (although two of its six members recorded a dissenting report) (Edwards, 1985). Finally, concerning the question that PVR would encourage an 'abnormal' dependency upon seeds linked to chemicals, this was rebutted by, amongst others, the federal Minister for Primary Industry (Australia, Department of Primary Industry, 1982: 2).

With those perspectives in mind, we now rum to the broader context within which PVR is embedded in order to attain a better understanding of where PVR fits in the Australian context.

The Broader Context

The broader context of PVR represented by biotechnology development followed or preceded the introduction of PVR/PBR, dependent on the timing of any particular country's adoption of it. For example, the USA introduced PBR in 1970 and, in 1980 and 1984 respectively, introduced

the 'process patent and 'product patent' with regard to genetic engineering (GE).

These events preceded the Australian situation where PVR was introduced in 1987, followed by the (amended) Patent Act 1990. 'The broad range of patentable subject matter is very similar to that in the US (Santer, 1999:33). As Byrne (1990:8) noted about the Australian response to international developments: "The Australian patent system and plant variety rights system together provide a comprehensive system in Australia for the legal protection of plant materials, and contribute to the international legal order for the protection of advances in biotechnology." Australia further strengthened its position through the PBR Act 1994 (which replaced the 1987 PVR Act). The new Act expanded the concept of property rights to include all plant types not commonly known, including genetically engineered constructs.

The introduction and/or amendment of intellectual property rights (IPR), such as those above, are part of policy initiatives designed to adapt to changing circumstances involving the commercialisation of innovations. Daly (1985) describes IPR as a form of government intervention known as targeting policies. With regard to genetic engineering IPR (though controversial, as critics charge that scientific breakthroughs concerning genetic material are more the case of discovery than invention) they were introduced during the 1980s as a key component of a range of innovation incentives to stimulate biotechnology as a much-heralded sunrise industry.

Another key incentive put in place during that time by OECD government policy agendas was public-private sector collaboration. Subsequently, the biotechnology R&D consortium emerged in attempts to achieve competitiveness through economies of scale and rapid innovation. Italy, for example, established the 'Inter-University Biotechnology Consortium' laboratory network to carry out industrial research (Oggi, 1990). In Australia, the lynchpin for private-public sector collaboration has been the Cooperative Research Centres (CRC) programme, established in 1990. The programme promotes long-term, high-quality public-private sector collaboration in centres underpinned by a competitive grant system; and partners involve industry, government (particularly the CSIRO), and a higher education institution. Biotechnology has been a key recipient of funding

in this programme (Ernst & Young, 1999).

Such factors, together with tax concessions and a broad sweep of government grants and loans for biotechnology R&D, have stimulated business involvement. Such involvement though has been underpinned by 'technology strategy', which has seen corporations, since their market entry into biotechnology in the early 1980s, now controlling some 20-30 per cent of the GE industry worldwide. Technology strategy (or strategic planning involving technology) consists of seven interactive areas that include in-house R&D programmes; funding of research (strategic partnerships) with purchase of equity in, or takeover of, small biotechnology firms; strong external collaborative R&D networks with academia; some inter-corporate collaboration; takeover of seed (genetic supply) and plant breeding companies for control over strategic seed markets; formation of industry and trade associations; and policy coalitions that act to shape government policies and legislation (Hindmarsh, 1998).

In summary, intellectual property rights are clearly an integral leverage point for innovation, but are they also a leverage point for agribusiness interests to consolidate control of the agriculture sector in Australia? To answer this we need to continue our exploration of the broader context of PVR represented especially by corporate seed technology strategy. In this context, it is essential to emphasise that, despite where the IPR emphasis is in the biotechnology field – be it any section/s of a gene, a gene, a gene sequence, or a plant variety – the seed is a crucial lynchpin for agribusiness restructuring.

Corporate Seed Technology Strategy

The seed – as a package of DNA – has been described by Kloppenburg (1988:201) as the 'vector' for agro-technological change between research and development (R&D) and the market, and as such has been defined as a vehicle of 'control'. Robert Fraley, chief executive of US chemicals/life sciences giant Monsanto underscores this point: "What you're seeing is not just a consolidation of the seed companies, it's really

a consolidation of the entire food chain" (see RAFI, 1996:2). Since the early 1980s, corporations have invested billions of dollars in acquiring seed and plant breeding companies worldwide. Fowler and Mooney (1990:118-123) estimate that in the two decades from 1970-1990, multinational 'life sciences' corporations brought under their control nearly a thousand formerly independent seed and plant breeding companies.

Commercial opportunities offered through control of the seed include global access to, and control over, distribution systems (through IPR and licensing) and proprietary gene pools; as well as skilled labour forces capable of putting engineered genes into marketable form (Pisano *et al.*, 1988:212); profitable returns attained through highly-priced transgenic seed; and defense against competitors (including other companies, and alternative forms of agriculture such as organic farming). Some 90 seed companies are now competing for the predicted US$20 billion opportunity for GE seed varieties by the year 2010. This is 80 per cent of the entire global commercial seed market (RAFI, 1999b: 1).

Although seed purchases constitute a relatively low portion on average of a farmer's total production costs (2.8 per cent in the US in 1992), they may be significant at the individual level (Rawson, 1993:5), and promise to become more significant through genetic engineering. For example, in 1989, Biotechnica International projected that an 88 per cent gross margin could be made on the sale of its transgenic alfalfa seed (nearly double its then 46 per cent margin on ordinary alfalfa seeds), thereby increasing the proportion of total input costs accounted for seed from seven to 20 per cent *(The Economist*, 1988). Another UK firm, Agricultural Genetics, projected that by 2006, transgenic seed could constitute 40 per cent of total input costs *(The Economist*, 1987). No reasons were given in the literature cited for these projected price increases, so it is presumed that they 'm some way relate to the long R&D lead-time involved in bringing transgenic seed to market, as well as to monopoly ownership of genetic material contained in the seed. One form of the latter has already been demonstrated by Monsanto's use of a 'technology fee' for its GE soybean seed based on the presence of a patented gene (as discussed below).

A key market opportunity involves bioengineering seed to contain genes that code for natural biotoxins or pesticides, such as those already utilised from the soil microbe *Bacillus thuriengiensis* (Bt) in order to control pests like *Heliothis amgira* (Salleh, 1998). Traditionally, Bt has been used as a discretional bacterial spray for occasional or emergency pest control by organic farmers. In 1998, over 20 per cent of the US cotton acreage was sown with Monsanto's genetically engineered Bt cotton, and this acreage is increasing, especially in areas where insect resistance has

developed to the synthetic insecticides called pyrethroids (Hayenga 1998). However, its use is hampered by complex technical problems that undermine the capability of GE crops to perform consistently under differing climatic and environmental conditions (see Traavik, 1999). In Australia, Bt cotton has also been commercialised though on a limited scale (also discussed below). The commercial opportunity presented by the biopesticide approach to technologically shape a new Integrated Pest management (IPM) approach, is indicated by the following data: by June 1998, 482 patents had been submitted or awarded that mentioned Bt.: the top ten patentees held 62 per cent of these patents, and the top five patentees were the multinational companies Dow Agrosciences, Novartis, Monsanto, Novo-Nordisk, and AgrEvo (Jenkins, 1998:16-17).

Another key area of R&D, and the most focussed upon to date, has been crops genetically engineered to a company's herbicide/s. With a sales projection in the near future of US$6 billion for herbicide-tolerant plants, over 27 corporations conduct herbicide-tolerant plant research, including the world's largest pesticide (or redefined 'life sciences') companies. The Monsanto US target in 1999 for 'Roundup-Ready' (RR) soybeans, already planted extensively in the US, is 50 per cent of the 70 million soybean acreage (Hayenga, 1998). As well as seed and extra Roundup sales, Monsanto is raising its revenue through a US$6.50 technology fee added to every bag of RR soybean seed based on the presence of a patented gene that expresses resistance to the herbicide Roundup. One estimate is that if 50 per cent of the US soybean acreage is planted to RR soybeans, Monsanto will collect more than US$200 million in such technology fees *(Ecology and Farming* 1999:7). To further increase returns, Monsanto also requires the farmer to sign a contract stating that farmers cannot replant RR seed. One concerned farmer stated: "So now

we see the chemical companies not only marketing chemicals to us, but controlling in the seed market" (cited in Holmstrom, 1999:2).

As indicated above, the rapid deployment of genetic engineering has resulted in an enormous increase in biotechnology patents over the last decade. Concomitantly, the buy-out of seed companies has actively continued. By 1992, industry figures indicated that the 10 largest multinational seed houses controlled about 20 per cent of global commercial seed sales (Pike, 1992). By 1998, this share was estimated to be 30 per cent, which amounted to a US$7 billion portion of the $23 billion market (RAFI, 1998a). The year 1998 also marked a 69 per cent increase in biotechnology-related patent lawsuits. Another development, in the latter part of the 1990s, was the emergence of the mega-life sciences corporate merger. A significant outcome of such mergers is a trend towards monopoly ownership of key biotechnology patents.

At the peak of the top tier of biotechnology conglomerates is Aventis, formed in late 1998 through a merger of Germany's Hoechst and France's Rh6ne-Poulenc. Next is Novartis (Switzerland) formed by the US$27 billion merger of Sandoz and Ciba-Geigy in 1996. To be more competitive, another top tier member, AgrEvo (representing a merger of Hoechst and Schering, Germany) acquired Nunhems Seeds of the Netherlands and US company Sunseeds in 1997. Together these seed companies are ranked fourth worldwide in vegetable seeds (AgrEvo, 1997:1). In late 1998, AgrEvo then acquired the giant Cargill Hybrid Seeds North America for US$650 million. Like Monsanto, AgrEvo has millions of acres in the US already planted to its own herbicide resistant (Liberty-Link) corn and canola, and also has Bt corn on the market (AgrEvo, 1998:1). Another top tier conglomerate, Monsanto (USA), acquired Cargill's international seed operations, also in 1998, for US$1.4 billion. Yet, another one, DuPont, recently bought out the world's largest seed company, Pioneer Hi-Bred, for US$7.7 billion (Pioneer Hi-Bred, 1999). Notably, all these companies also operate in Australia where they dominate the chemicals and agribusiness sectors (see Sargent, 1985). Some of them have made key biotechnology acquisitions, and have collaborative R&D programmes established, in Australia (Hindmarsh, 1998:95).

An emerging key strategy for restructuring the agricultural production process is to genetically engineer cereals. Until recently, cereal R&D was left to public sector plant breeders because hybridisation was technically difficult and thus very costly. Genetic engineering has made this less difficult and has encouraged a radical shift in grain R&D. Many life sciences corporations are now undertaking GE research to develop a broad range of male-sterile cereal and other seeds which will innovatively expand the market for agribusiness inputs. Critics have cast these seeds disparagingly as 'terminator' varieties (see Kluger, 1999). An associated and emerging R&D area is to develop terminator seeds to turn 'output' traits, such as nutrition and flavour, on and off through the catalyst of an external chemical 'inducer' mixed with a company's patented agrochemicals. In other words, seeds will only develop into productive (but sterile)

crops if sprayed with a company's pesticide or fertiliser (Holmstrom, 1999). Given this broader context into which PVR is embedded, let us now turn to the Australian seed and plant breeding industry.

The Australian Seed and Plant Breeding Industry

In terms of plant genetic resources, the Australian agro-economy comprises the production of plant material for reproduction as a crop (such as grain, pasture, fruit or therapeutic); crop production; and the processing, marketing, retailing and consumption of the product(s). Some 85 per cent of plant breeding is done by the public sector, including the CSIRO, state departments of agriculture and a number of university departments (Australian Science and Technology Council, 1993). As is the case overseas, public sector breeding organisations have traditionally focussed on major cereal and pasture crops such as wheat and barley. They produce open-pollinated seed and supply 'foundation' stock to a few selected (registered) seed growers who multiply it under strict conditions for sale to commercial grain growers.

In contrast, private seed companies traditionally concentrate on crops for which hybrid seed can be viably and profitably developed, such as sorghum, sunflowers, safflower, maize (corn), millet, cotton, canola, ornamentals, and some hybrid wheats. This is now beginning to change

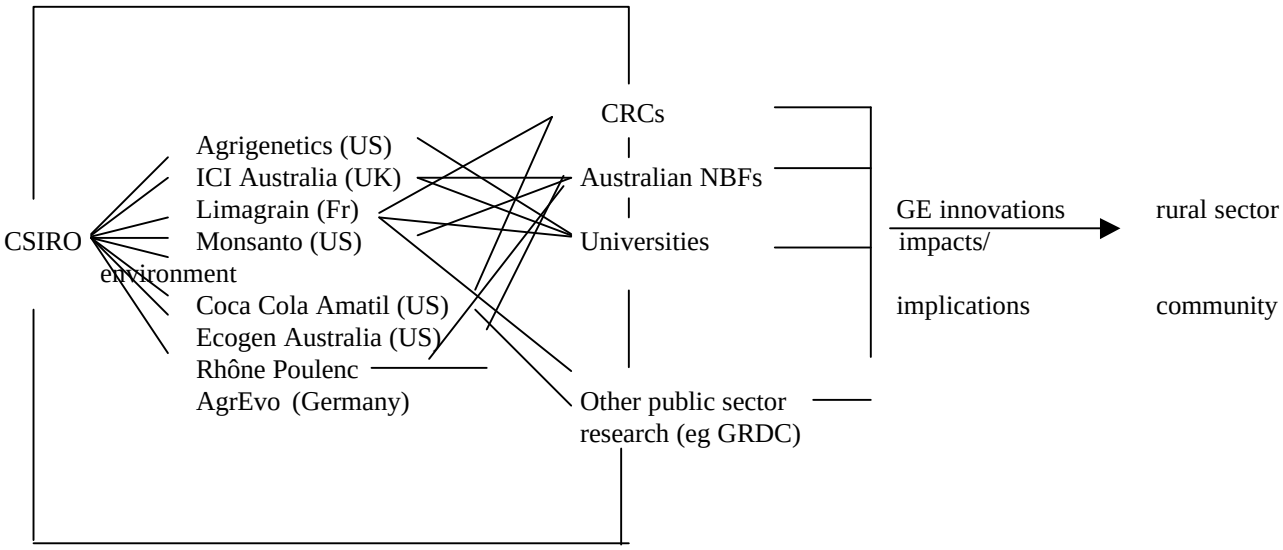
under the impact of genetic engineering breakthroughs, and through public-private sector collaboration incentives and programmes in Australia that tend to support the technology strategy of multinational companies. Indeed, with regard to the broader context of agri-food production within which biotechnological change is embedded, Lawrence (1996:65) reports that Australia has now adopted a deregulatory, free market approach; is promoting 'clean/greed product images to consumers; and is relying upon transnational agribusiness (and other forms of corporate involvement) to link local agriculture with global markets.

These factors, in addition to IPR developments, coupled to the R&D programmes of key Australian public sector research institutions like the CSIRO and the Waite Institute which have long been aligned to intensive agricultural R&D and agribusiness, are tending to generate convergence between private sector and public sector plant breeding operators. The CSIRO, in keeping with its position of being at the forefront of scientific research, prioritised genetic engineering research in 1979. CSIRO scientists have since been very active in the promotion of GE to the Australian community, and especially to other scientists (Hindmarsh, 1996). In addition, multinational companies are seen as the key avenue to the international commercialisation of biotechnology products and research of both Australian public sector institutions and biotechnology firms. A key programme to bring the public and private sectors together has been the Cooperative Research Centres programme introduced in 1990,as noted earlier. The CSIRO has played a key role in these centres, and multinational companies like Groupe Limagrain and Zeneca subsidiary Pacific Seeds have participated. Furthermore, by 1990, over 70 per cent of Australian biotechnology firms had formed some type of strategic alliance with an overseas partner, the largest number being with firms from Europe, then the US and, much less, Japan (Beggs and Fayle, 1985; Scott-Kemmis *et al.*, 1989).

Like the situation overseas, albeit much smaller, the indications are that a Byzantine web of formal contractual obligations and informal connections has emerged between the CSIRO and other public-sector agencies like the Grains R&D Corporation, universities, small or new

biotechnology firms (NBFs), and multinational corporations. Figure 1 illustrates some of the key linkages in this web.

Figure 1: Examples of Genetic Engineering R&D Linkages Between MNCs and Australian Private and Public Sector Breeders at Various Times Between 1986 to 1999, and their Relationship to the 'External' Environment



Key:

CRCs	Cooperative Research Centres
NBFs	New Biotechnology Firms
GRDC	Grains Research & Development Corporation
MNCs	multinational corporations
GE	genetic engineering

To more fully understand why this convergence is occurring, and how it relates to McQueen's predictions, we now turn to its historical context and the place of PVR in it.

Pre-PVR Australia

From the early 1980s, and prior to PVR, the Australian hybrid seed industry displayed a trend towards oligopoly and concentration under the impact of global agribusiness restructuring. A prime target for multinational investment was the Australian oilseed industry which had significantly expanded during the 1970s. Fierce competition saw Cargill (Tradax) and Continental Grain survive other major seed producers, including Australian companies Meggitts and Yates. Due to poor market position, Yates hybrid seed division was sold to Australian agrichemical and spray contractor multinational Agro Services in 1984. A year later, the remainder of Yates was taken over by Australian salt company Cheetham which also took over Hortico.

Eventually 11 larger companies (both local and multinational) came to dominate the 150 member Seed Industry Association of Australia. The top tier, with an annual total turnover of $75-90 million, included Wright Stevenson

(Fletcher Challenge NZ), Seedco, J.H. Williams & Son P/L, Henderson's, Yates, New World Seeds, Pacific Seeds, Dekalb Shand (USA), Pioneer Hi-Bred Seed (USA), Cargill (USA), and Ag Seed P/L (PVR Registrar, nd).

Monopolies already existed in Australia for rice and cotton seed supply. The latter is monopoly-controlled by Cotton Seed Distributors (CSD) who acquire over 95 per cent of their seed from the CSIRO. Both CSD and CSIRO obtain their elite lines of seed for cross-breeding purposes from two US companies, Cokers Pedigree Seed and Delta and Pine Land (which, at the time of writing, was awaiting formal US approval for Monsanto's take-over bid for it).

Lobbying for PVR in Australia began in the late 1960s as an initiative of the horticultural and ornamental plant industries (see Brentnall, 1982). The industry lobby group—the Industry Committee for Plant Breeders Rights (ICPBR)—emerged, and included Continental Overseas Corporation (USA), Yates (Aust.), Wright Stevenson (NZ), New World Seeds and Shell Australia (UK/Dutch). The ICPBR also represented the Seed Industry Association and the Australian Nurseymens Association. Other pro-PVR lobbyists included the Australian Seed Producers

Federation, the Industries Assistance Commission, the Australian Agricultural Council (which comprises government ministers responsible for primary industries), the International Union for the Protection of New Varieties (UPOV), the Industry Council for Development (funded by 32 multinational companies), and the Grains Research and Development Corporation (O'Keefe, 1991).

Such was the intensity of debate over PVR that the pending Bill was described as "the most controversial farm legislation for a decade ... PVR ... generated more steam, more lobbying, more parliamentary mail and letters to newspapers than any farm issue for a very long time" *(National Farmer 1982:* 1 0). Opponents of PVR such as the Plant Diversity Protection Committee (PDPC) campaigned vigorously against its introduction. Conversely, proponents of PVR campaigned vigorously in favour of its introduction. Part of the proponents' campaign was to withdraw open-pollinated corn seed varieties from the Australian seed market and replace them with hybrid seed, to demonstrate that seed companies could theoretically withhold seed unless it was protected (O'Keefe, 1991:5).

Genetic engineering for plant breeding was also promoted earnestly pre-PVR. Reflecting the international promotion about biotechnology's promise for global economic competitiveness and scientific progress, the Department of Science began to enthusiastically promote Australia's place in the world's 'top biotech 10'. In 1981, large companies began to invest in Australian biotech R&D, with Austgen, CRA Australia and BHP collaborating with university laboratories undertaking recombinant-DNA research (see Hindmarsh, 1998:46). An early federal government initiative was the 1983 National Biotechnology Programme Research Grants scheme.

Post-PVR developments

After the PVR Act of 1987 was introduced, concentration continued. However, intense biotechnology developments were occurring during the same time, which makes it difficult to demarcate which event or circumstances was the stronger catalyst for restructuring in general.

Some concentration, however, was clearly influenced by PVR. For example, local multinational company Elders LXL quickly established a seed network covering the eastern seaboard with the acquisition of Fuller Seeds in Brisbane and West Seeds in Melbourne which were added to its Hodder and Tolley seeds operations in Sydney, purchased by Elders in 1985 (Anon, 1988). The "full-scale assault on the Australian seed market" was undertaken to address new opportunities created by the impending introduction of PVR (de Silva 1988:27) Later, Elders also developed an interest in biotechnology (Nugent, 1988).

Biotechnology US spin-off Calgene Pacific P/L (now Florigene of Melbourne) also purchased three prominent Australian nursery companies in 1987. These gave it access to 80 per cent of the mainland population (Calgene Pacific, 1988). Also taken over was Crompton-Hannaford P/ Australian seed and grain machinery manufacturer and a major supplier of seed treatment chemicals (as the Australian distributor for Swiss company Bayer Australia). That acquisition expanded US company Uniroyal Chemical's business in seed treatment chemicals and the supply of new improved seed varieties (Anon, 1987).

In 1988, a joint venture called Gene Shears PIL was established between Groupe Limagrain Pacific (the Australian subsidiary of French multinational seed company Groupe Limagrain) and the CSIRO, to commercialise CSIRO's 'gene shears' technology. Limagrain financed the joint venture for $22.5 million to produce transgenic seeds (Stannard, 1991). A range of virus-resistant vegetable crops is presently being developed. The following year, 1989, saw multinational corporation ICI (Imperial Chemical Industries) Seeds (UK) purchase Pacific Seeds (originally an Australian firm but taken over by Continental in the 1970s), and ICI (Australia) purchase Incitec, a leading Australian fertiliser company and a leader in controlled release pesticide formulation technology. With the later restructuring of ICI, Pacific Seeds became a member of ICI 'life sciences' off-shoot Zeneca Seeds.

The restructuring of Australia's seed and plant breeding sector was facilitated next by the Patents Act 1990. The new Act contained no reference to biological material (excepting human and micro-organisms). By exclusion, this implied that all plant and animal biological material could be patented. Just prior to the Act being passed, Australian-New

Zealand agribusiness interests (Primac Association and NZ Agriseed), through their joint venture Heritage Seeds, acquired the seed division of Elders IXL. Heritage Seeds was well placed to take advantage of GE technology through its research linkages to Ciba-Geigy, and through NZ Agriseed's Dutch and Swedish corporate shareholders (Code, 1994).

Soon after the Patent Act 1990 was passed, Ag-Seed Research P/L (which specialises in canola and sunflower) was established, where the major shareholder is Biocem Pacific (one of the four worldwide biotechnology research laboratories of Groupe Limagrain). Before the takeover Ag-Seed Research was formerly the research division of Australian seed company Ag-Seed PIL. It was undertaking joint oilseed research with the Victorian Department of Agriculture and Rural Affairs (Anon, 199la:12). Limagrain holds first option to commercialise and further develop Ag-Seed Research products internationally.

Under the impact of increasingly strong competition, amongst other factors, small Australian seed growers then began to restructure. One company to emerge in 1991 was Vicseeds P/L, formed by 40 growers of pasture seed from all parts of Victoria (Anon, 1991:4). Another to emerge, in 1992, was Cultivar Marketing, the result of four Queensland based seed companies merging. A company spokesperson stated that its formation was "a recognition of the acceptance of Plant Variety Rights and in turn the marketing of more and more protected species" (Anon, 1992:30). This statement highlighted McQueen's concern that a preferential market for patented varieties would emerge under the impact of PVR legislation. In 1993, the Plant Breeders & Proprietary Marketing Group formed, with dominant local and overseas seed companies well represented. Its purpose was to set up protocols Australia-wide to improve the framework for the various stages of trial performance and merit testing for the introduction of PVR varieties (Coad, 1993:9).

More restructuring occurred during the next year. Henderson Seeds and Sunseeds USA announced an extensive development programme to breed and introduce carrot varieties for the fresh and export markets in Australia (Anon, 1994a:18). A major IPR adjustment for plant varieties also occurred in 1994. The Plant Breeder's Rights (PBR) Act replaced

the PVR Act.(2) The PBR Act widened the scope and protection of breeder's rights by recognising that biotechnological developments might reduce the effectiveness of protection. It thus allowed the registration of transgenic plant varieties, amongst other things (see Hancock 1998:105).

A typical corporate argument for the 1994 Bill, and which echoed corporate arguments for protected varieties prior to the 1987 Act, was provided by Pioneer Hi-Bred Australia (1 994b: l):

> The ability of companies such as ours to develop transgenic material could be more important to the future development of agriculture than the original development of hybrids some 80 years ago ... Should it not be made possible for companies such as ours to register under PVR in this country transgenic plants then Australian farmers will be unable to access such products as BT cotton varieties and corn hybrids which have the potential to be released in three years.

Cotton has since been a key variety targeted for GE development by multinational corporations. For example, AgrEvo established a joint venture in 1997 with Cotton Seed International (CSI)—a subsidiary of Cotton Seed Distributors (CSD). AgrEvo Cotton Seed International (ACSI) is headquartered in Memphis (AgrEvo, 1997). As noted before, CSI, through CSD, has exclusive access to the cotton breeding program of the CSIRO, which commands a 90 per cent market share in Australia. The following year, in 1998, CSIRO, with the Australian National University, announced a five-year strategic research alliance to collaborate with AgrEvo to develop "innovative enabling platform technologies", including pest and disease resistant crops and cotton fibre quality improvement. The alliance gives CSIRO ownership of intellectual property associated with the research projects, while AgrEvo will obtain licenses for a range of crops including cereals, vegetables, oilseeds and cotton. At the same time, AgrEvo will improve its

distribution of its agribusiness technologies to Australian farmers through the CSIRO (CSIRO 1998a: 1).

Field trials of GE organisms are an essential part of biotechnology R&D. There are a number of seed varieties under development for Australian conditions. Genetically engineered varieties at the field trial stage include fungal disease resistant canola cultivars; pea seeds; blight resistant field peas; lupin seeds expressing sunflower seed albumin; and virus resistant barley, white clover, and lettuce. But by far the primary focus is upon herbicide tolerant varieties followed by insect resistant varieties. Table 1 shows some herbicide-tolerant crops under field trial in Australia along with their developers.'

Table 1: Genetically-Engineered Herbicide-Tolerant Crops Under Development in Australia

Developer	**Product**
AgrEvo	glufosinate ammonium resistant canola
AgrEvo	glufosinate ammonium (LibertyLink®) tomatoes
AgrEvo	herbicide-resistant Indian mustard (*Brassica juncea)*
Monsanto, Delta Pine	glyphosate resistant (Roundup Ready®) cotton
	Roundup Ready® canola
CSIRO	glyphosate resistant cotton
CSIRO	2,4-D resistant cotton
CSIRO	Roundup Ready® and insect-resistant (INGARD®) cotton
CSIRO	bromoxynil resistant cotton
CSIRO	Basta® resistant cotton
CSIRO/Ag. Research Inst. of NSW Agriculture/Plant R&D Services	bromoxynil resistant subterranean clover
Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA)/University of Western Australia (WA)/Nedlands WA	Basta® resistant lupins and Liberty® resistant peas
CLIMA	Basta® resistant lentils
CLIMA	LibertyLink® lupins

Source: Genetic Manipulation Advisory Committee (deliberate release proposals - public gazette notices 1990-1999).

With regard to insect-resistant varieties, cotton is currently the key focus of R&D, and the CSIRO again is keenly involved. Significantly, a collaboration between the CSIRO and Monsanto has generated Australia's first major GE commercial crop. The CSIRO licensed Monsanto's patented Bt Cry IA(c) gene, the Ingard® gene, and inserted it into local varieties of cotton, which are now sold by Cotton Seed Distributors as Monsanto's PI Ingard® cotton. In 1997, 30,000 hectares was planted which was increased to 60,000 hectares in 1998, and in 1999 this is to be increased to 90,000 hectares. Its increasing widescale release though is accompanied by grave reservations held by many

commentators, both inside and outside the industry, that the constant expression of Bt toxin in transgenic cotton will rapidly create a resistance of the heliothis caterpillar to Bt (Salleh, 1998). To diminish the prospects of resistance, apart from introducing a field management regime, R&D is underway to produce a two-gene Bt cotton crop (where the second gene is a different strain of Bt to the first Bt strain).

In late 1999, the fear of widescale resistance emerging rapidly to PI Ingard® cotton prompted farmers and the Australian Cotton Industry Council to demand urgent access to the two-gene cotton (McAulay, 1999a: 1). Facing problems of 'huge' local resistance, one farmer from the Callide Valley in Queensland said, "It is imperative that we have access to the two gene technology as soon as possible" *(Queensland Country Life,* 1999:1). In response, Monsanto has refused to make available P2 Ingard® technology, citing the reason to be inconsistent yields from trials throughout Australia and overseas. Monsanto is instead developing a third gene, CryX, which is four to five years away from commercial release. Yet, the CSIRO in conjunction with Cotton Seed Distributors, and supported by farmers field trialing the P2 Bt cotton, argued that there were no problems with yield in the Australian field trials (McAulay, 1999a:l; McAulay, 199b:5). So concerned was the Australian Cotton Industry Council about Monsanto's access refusal, that its Chairman, Peter Corish, posited the industry would be willing to indemnify Monsanto against any liability if yield drag or agronomic problems should arise involving the P2 cotton (McAulay, 1999a:l). So far, Monsanto has not taken the offer up. This situation vividly echoes the concern of McQueen (1980) that PVR legislation, combined with seed industry takeovers and the convergence of private and public sector plant

breeding, would lead to a strong dependence of Australian farmers upon large agribusiness for patented seeds and technology inputs.

Similarly, the same issue of crop technological dependency upon multinational corporations' IPR, and private-public sector collaboration, was raised again recently in Western Australia. Holding some of the intellectual property rights to a GE lupin resistant to its herbicide Basta®, developed by the Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA), AgrEvo prevented commercial release. The grounds for the constraint was that the release did not fit into AgrEvo's global marketing strategy for Basta® (Copeman, 1999).

The Grains R&D Corporation (GRDC) is yet another key Australian public sector developer of genetic engineering. In the early 1990s, a GRDC-funded biotechnology review panel enthusiastically encouraged the GRDC to invest in genetic engineering. The panel included representatives of the PVR Advisory Committee, a Calgene Pacific executive, the National Farmers Federation, and the Grains Council of Australia, all of which supported genetic engineering and plant breeders' rights. The GRDC funded Calgene Pacific during 1991-1993 to develop herbicide-resistant lupins, notably the world's first successful genetic transformation of lupins (Scitech, 1993). In early 1997, the GRDC funded Australia's first field trials of transgenic wheat varieties aimed at improving their agronomic performance and grain quality (CSIRO, 1997:1). The trials were undertaken by a Cooperative Research Centre involving the CSIRO Plant Industry division and Groupe Limagrain.

The latest GRDC GE initiative is a joint research venture (Grain*gene*) with the Australian Wheat Board (AWB) and the CSIRO Plant Industry division, to develop novel plant products. Significantly, in a dramatic reversal of its usual position of applauding multinational involvement in Australia's gene industry, the CSIRO (1 999: 1) issued the followed press release:

> With the prospect of large multinationals taking control of the Australian grain industry's genetic intellectual capital, AVY'B Limited, the CSIRO and GRDC through Grain*gene*, are taking a leading position with this technology on behalf of Australian growers.

This was supported by remarks from AWB chairman Trevor Flugge:

> Australia will be 'milked to death' by multinationals involved with gene technology, unless it develops its own intellectual property and has something to trade with these companies ... Australia ... would be at the mercy of the concentration of power currently occurring, unless it acted swiftly in securing bargaining chips" (cited in F@rming Online 1999:3).

Former CSIRO chief executive John Stocker's following statement typifies the usual CSIRO position:

> Working with the transnationals makes a lot of sense, in the context of market access. There are very few Australian companies that have developed market access in the United States, in Europe and in Japan, the world's major marketplaces. Yes, we do find that it is often the best strategy to get into bed with these companies (Australian Broadcasting Commission, 1992).

Stocker's position represents a long history of CSIRO collaboration with multinationals, its advocacy of globalisation as a key avenue for Australian biotechnology, and its increasing dependency upon industry funding. The 'new' CSIRO concern about multinational concentration in the context of IPR would thus suggest more a concern for improving CSIRO's IPR negotiation powers, and protecting its own resource base, than a concern *per se* about multinational concentration. This argument is upheld where the CSIRO is voluntarily increasing its target of 30 per cent external earnings, set by the government, to 40 per cent in its 20002003 plan because it doubts any increased government funding. According to the plan, Pockley (1999:15) reported, "Research will be run like an 'investment portfolio' and growth will be 'demand-led' by clients and research collaborators."

A steady decrease in university funding from the state has also seen universities seeking increased industry support. Perhaps a recent commercial agreement between Swedish biotechnology pharmaceutical multinational AstraZeneca and Brisbane's Griffith University signals an era of an even tighter interlocking of biotechnology private-public sector R&D in Australia. The world's third largest pharmaceutical company

recently invested in the Queensland Pharmaceutical Research Institute at Griffith University to the extent that the institute renamed itself the 'AstraZeneca R&D Unit, Griffith University' (*The Australian, 1999).*

From this web of company takeovers and private-public sector R&D linkages, we now turn to our final focus of attention, PVR/PBR registration trends. This area may provide more insights about preferential markets emerging for patented seed of multinationals in Australia.

PVR/PBR registration trends

In 1989, two years post-PVR, the federal Bureau of Rural Resources reported that a possible future pattern might be that the private sector would be involved in breeding (or otherwise obtaining and marketing) a wide range of plant varieties, while public sector organisations would carry out the background work. The Bureau continued, "indeed, this is beginning to occur" (see Avent, 1989:62). This sentiment would appear to support McQueen's thrust about public sector breeding becoming aligned to private sector breeding preferences, but what do the latest registration trends suggest?

In 1990, PVR Registrar Kathryn Adams noted that 70 per cent of the 100 PVR applications for that year were from overseas, and further commented: "As PVR develops in Australia I hope to see the balance swing the other way with 70% of applications coming from Australia" (Anon, 1990:3). Recently, there appears to have been a swing to Australian applications. According to a PBR Registrar examiner (*pers comm., 15* August 1999), the total number of PBR applications in 1997 was 347 of which 158 were from overseas (46 per cent). Of the 276 applications lodged the following year, in 1998, 106 were from overseas (38 per cent) (see also PBR Australia 1999). This amounted to a decrease of 10 per cent from 1997 to 1998 for overseas applications, and may thus indicate that the number of Australian applications are increasing to the detriment of overseas applications. However, at least six of the above applicants for 1998 were subsidiaries of multinational corporations, so the percentage of overseas applications would then increase to 40

percent. Public institutions that have clear corporate R&D connections account for another 19 applications (or 7 per cent). The figure for overseas applications (by association) could then arguably be adjusted to 47 per cent.

Thus, although the 1997/1998 figures would appear to represent a clear swing of 20 per cent away from the 1990 figure, there are compounding factors which imply that the 199711998 figures do not represent a realistic picture of

PVR registration trends. This is because, according to the PBR examiner (mentioned above), and which supports the above but limited perusal of the data, there is a trend emerging which questions any view about a concrete swing occurring. This trend would indicate Australian public-sector partner/s in strategic alliances with private sector partner/s negotiating deals where the public-sector partner/s register a plant variety in exchange for a concession to the private-sector partner/s elsewhere, for example, in licensing arrangements. Such deals though are masked by commercial confidentiality conditions, and PBR data is also restrictive in its information, so it is difficult to get any clear picture of what is really happening. In addition, there are other factors that affect PVR registration rates, such as public sector economic rationalisation in public breeding programmes, and disincentives to private sector investment for one reason or another (see Lloyd, 1994).

Conclusions

There can be no doubt that the Australian seed and plant-breeding industry has experienced restructuring, not just as 'normal' business activity, but in response to the trigger of PVR legislation introduced in 1987. Local and international restructuring occurred in direct response to PVR. Takeovers of Australian seed companies have resulted. McQueen (1980) is correct to have predicted that PVR would be a leverage point for agribusiness interests to consolidate control of the Australian agricultural sector. There is ample evidence of this. The real question though is just how significant a leverage point has been PVR.

Developments in biotechnology, itself subsumed into the processes of globalisation and agri-food production, have induced a restructuring

worldwide of the agricultural sector that has blurred the significance of PVR. As a technology of globalisation (Hindmarsh, 1998), multinational corporations have adopted biotechnology as a key strategy, supported by an array of state incentives targeted to biotechnology as a sunrise industry. This broader context has been the more significant catalyst for restructuring and the role of PVR has been submerged into it. Together with other IPR developments, PVR can be seen as very significant, but the demarcation between industrial patents and PVR, originally quite distinct, has become blurred by developments in biotechnology.

It is with reference to this broader context that we can also better respond to McQueen's other predictions. As a result of the biotechnology context including IPR developments, seed company takeovers, and mega-corporate mergers, a steady trend to convergence between the private and public plant breeding, crop protection, and seeds sectors is now resulting in Australia, similar to trends overseas. McQueen was correct on that score, yet it should be noted that the alignment of Australian public-sector plant breeding to agribusiness preferences has experienced a long history over many decades. Genetic engineering is an outgrowth of that process, and IPRs associated with plant breeding and biotechnology have strengthened that alignment leading to the increasing convergence apparent today.

Yes, access to overseas varieties has improved but in the process a preferential market is now being created for transgenic seed, in the wake of an already well-established dependency for seeds dependent on chemicals. At the forefront of the transgenic market emerging is the herbicide-tolerant variety which, if overseas trends are correct, will entrench and increase the chemical load of intensive agriculture. In addition, the example of Bt cotton in Australia (and Monsanto's refusal to release the P2 Bt cotton) supports the prediction of McQueen about dependency upon the seed and its associated technological inputs of a multinational company being created, as well as about access to seeds being restricted. To make matters worse, this was a direct outcome of a collaboration involving a leading Australian research institution-the CSIRO.

The concern about dependency was heightened by the AgrEvo refusal to allow the release of Basta-resistant lupins, developed by another

Australian public-sector collaboration. Furthermore, it is no longer just the 'critics' pointing up the arguments about dependency, but leading proponents of GE seed, such as the CSIRO and Australian Wheat Board, who have stridently voiced their concern about multinational control of the production process through IPR. Yet, at the same time, there appears to be no protest from proponents about the private-public sector interlocking of R&D. Indeed,

this is being canvassed as the 'way forward'. The issue for the proponents thus appears to be more about improving intellectual property capital rather than one about the overall production context, a domain now being heavily stacked globally to multinational control. Indeed, the latter situation begs the question: Is this really a feasible way forward when mega-corporations are increasingly controlling key biotechnology patents? What are the Australian proponents really negotiating for in this situation? Some extra research funding, or which corporation gets the licence/s to control the production process, or which corporation forces the licence?

Another concern of the critics was that PVR would lead to a shrinkage in plant variety diversity which would be facilitated by cosmetic rather than substantial changes occurring to the seed. This concern is difficult to analyse in the context of this article, and really demands a comprehensive study of PVRJPBR registrations. The indications, however, are that a trend to diminishing diversity may be emerging under the impact of biotechnology and associated IPRS. The reasons for this are first, that the historical record of intensive agriculture shows a general decline in diversity occurring (for example, see Fowler and Mooney, 1990), second, that trends to concentration within the commercial seed industry would facilitate less diversity, and third, that much genetic engineering R&D appears focussed upon product differentiation and the narrow commercial imperatives of multinational companies.

Finally, while a lot more could be gleaned from this exploratory study, and while much fertile ground exists for further research, its findings appear sufficient to challenge the view of the Senate Standing Committee on Rural and Regional Affairs (1994:50) that the impact of PBR would not lead to corporate domination of food supplies through monopoly control of cultivars, a view challenged also by critics such as McQueen nearly two decades ago. Since that time it is more apparent that the

groundwork for domination has been laid and that Plant Variety Rights has played an important role in consolidating that groundwork, as McQueen predicted.

End Notes

(1) From this point on, the term biotechnology is used to represent modem biotechnology and is also used interchangeably with genetic engineering. The term transgenic is also used to denote genetic engineering involving cross-species DNA transfer.

(2) (2) The name of the Act was changed to the *Breeder's Rights Act* as the 1991 UPOV Convention was "more logically and explicitly directed to the intellectual property rights of the breeder and not to that of the plant variety. There [was] no reference to 'variety rights' in the 1991 UPOV Convention" (Godden 1992:2).

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