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AN EXAMINATION OF THE POTENTIAL ECONOMIC EFFECTS OF PLANT BREEDERS' RIGHTS ON CANADA

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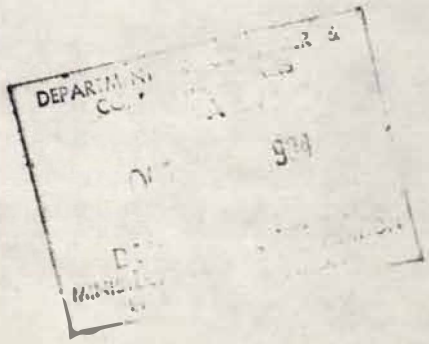
The analysis and conclusions of this study do not necessarily reflect the views of the Department.



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Although we have identified and acknowledged the contribution of others, we wish to make it clear that the results and conclusions in this report are the responsibility only of the authors. Funding and release of this material by Consumer and Corporate Affairs Canada does not mean or imply that the views expressed are those of that Department, nor should they be attributed to the University of Manitoba.

SUMMARY

APPROACH OF THE STUDY

During the recent debate on the introduction of Plant Breeders' Rights (PBR) into Canada, a number of claims have been made by both supporters and opponents of the legislation. An attempt to determine the validity of these claims led to the discovery that there was little published information on the effect of PBR in countries where similar legislation has been in effect for some time. This study was undertaken in an attempt to provide information on the possible economic effects of PBR on Canada.

The methodology of the study was to review the experience of similar product protection in other industries and to survey the experiences of members of the International Union for the Protection of New Varieties of Plants (UPOV), with special attention being given to the United States and the United Kingdom.

The first part of this study examined the patents system in Canada. Since PBR provides patent-like protection for new plant varieties, this examination was expected to provide some insight into the possible effects of PBR, especially its effect on research and development (R & D) activity.

Second, the performance of the pharmaceutical industry in Canada was examined, for two reasons: The widespread use of patents in the pharmaceutical industry makes it an excellent "case study" of the more general patent information which was also gathered; and it was expected that the structure of the Canadian seed industry might come to resemble that of the pharmaceutical industry if plant protection came into effect. A primary reason for this expectation is the recent interest in seed companies, both in Canada and abroad, by multinational firms engaged in the petrochemical and pharmaceutical industries. To gain further insight into the potential effect of such a change in structure, we studied the relationship between industry structure, firm size, R & D, invention and innovation.

Third, it was felt that the experiences of UPOV member countries, especially those of the United Kingdom and the United States, which have had some form of plant protection for 17 and 12 years respectively, could be drawn on. A detailed literature search for published information about the effects of PBR was carried out. In addition, members of the British and American plant breeding communities in both the public and private sectors, as well as members of the seed trade, were approached for their views on PBR in their respective countries. The Plant Variety Offices of various UPOV member countries were also contacted, either directly, or through the offices of Dr. Herbert Mast, Vice-Secretary General of UPOV, for information on the effects of PBR.

Finally, the opinions and experience of Canadian plant breeders and seedsmen were consulted regarding PBR, in particular their feelings about the effect of its absence on the industry.

RESULTS OF THE STUDY

Patents

Although there is some evidence that patents may increase innovative activity in Canada, there is considerable concern that the net effect of Canada's patent policy is negative. If the effects of PBR are truly analogous to those of patents, the conclusion of this study for PBR would have to concur with that of the Ilsley Commission (1960) about patents: "If we did not have a patent system it would be impossible on the basis of our present knowledge of its economic consequences, to recommend instituting one" (as cited in CCAC 1976, p. 61).

Industry Structure, Firm Size, Etc.

The research for this study leads to the belief that the introduction of PBR in Canada will not result in a change in the structure of the seed industry which will make it resemble the pharmaceutical industry more closely. However, if such a structural change did occur, it may be concluded that seed prices would rise unnecessarily. At the same time, private sector R & D activity would probably not increase substantially. However, this conclusion must be tempered by a number of considerations. First, with regard to price, there is an assumption implicit in the analogy with the pharmaceutical industry that the public sector will no longer act as a competitive market force through the release of public varieties. In considering the second conclusion regarding R & D activity, it must be kept in mind that unlike the pharmaceutical industry, the product of the seed industry is not likely to be homogeneous between markets and, therefore, the product of R & D for one market will probably not be adaptable to all markets.

The Experience of the United Kingdom and the United States

Contacts in these two countries strongly supported the view that there had been a significant overall increase in private investment in plant breeding since plant protection was introduced in their countries, although the distribution among crops seems far from uniform. There is, however, some dissension about whether the increase in investment is due to PBR or merely coincidental with it.

There has been little private interest in breeding for crops with smaller market size or for small geographic areas. Experts in the United States especially argued that this implies the need for a strong public program to maintain crops with smaller market penetration.

The level of public breeding in the United States and the United Kingdom is generally believed to have remained constant or to have declined slightly. It is unclear whether public breeders are doing more basic research than varietal development.

Seed prices have increased in both countries, but no more than other farm inputs. The evidence from the United States indicates, however, that private varieties usually sell at higher prices than equivalent public varieties.

There is little fear that multinationals will gain control of the seed industry in either country. However, many public sector plant breeders in the United States expressed the view that publicly released varieties are required to provide a strong competitive force in order to maintain this situation.

The costs of administering the PBR system in the two countries are unknown, but contacts expressed the view that the respective Plant Variety Offices are not yet paying their own way.

The rate of germ plasm exchange is believed to have remained unchanged in the United Kingdom, while there is some concern that it has declined in the United States. Although genetic vulnerability is an issue in both countries, it is generally recognized that it is separate and distinct from PBR.

Plant breeders in the United Kingdom were of the opinion that PBR has had a positive net effect, whereas U.S. breeders seemed to indicate that plant variety protection (PVP) has not had a dramatic positive or negative overall effect.

The UPOV Experience

The view of the majority of UPOV members who responded to the questionnaire[1] was that PBR had led to more private investment in plant breeding. A number of respondents indicated that private investment had definitely increased since the advent of PBR but was not necessarily due to PBR alone.

All but one of the UPOV members felt that there had been a shift toward more basic research in the public sector, although a number felt this was totally unrelated to PBR. Respondents were unanimous in the belief that PBR had not adversely affected germ plasm exchange at the international level, and some even felt that it had been enhanced. A

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1. Responses were received from the Plant Variety Offices of Belgium, Denmark, France, the Federal Republic of Germany, New Zealand, Sweden, Switzerland and South Africa.

majority indicated that the number of new varieties available had increased since PBR was introduced, and that their overall quality was an improvement over existing varieties. A minority felt that the introduction of PBR was not necessarily the cause for the appearance of many improved varieties. Royalty collection was unanimously deemed to entail no major problems. A large majority of the UPOV respondents felt that there had been no discernible change in the structure of the seed industry in their respective countries, and found no marked change in the participation of multinationals in their seed industries. Most respondents did not appear to know what effect PBR had had on net royalty flows on imported and exported seed. While seed prices have gone up in all countries since PBR came into effect, almost all respondents indicated that the increase was due to a general price rise rather than to PBR, and that the relative increase in seed prices was generally lower than for other farm inputs. There was almost unanimous agreement that PBR did not lead to an increase in the genetic vulnerability of cereal and oilseed crops. Respondents were unanimous in stating that the perceived overall effects of PBR were positive for their countries. The only possible negative effect which was mentioned was the cost of operating the system. None of the respondents recommended any changes in the present UPOV convention.

Canadian Views

The major concern in Canada seems to be that the federal government is introducing PBR in the expectation that increased private sector investment, or royalty earnings from public varieties, will allow it to decrease its support for plant breeding. There is support for the idea that SeCan already provides most of the protection PBR is intended to provide, and that this may be sufficient for Canada's needs if it can be expanded into international cooperation as well.

CONCLUSIONS

The results of this analysis have led to the conclusion that the introduction of PBR into Canada is likely to have neither a strong positive nor a strong negative effect. It is anticipated that the strongest argument for introducing PBR -- to increase private investment in Canadian plant breeding -- may not be valid, for two reasons. The first is the small and extremely diverse market which Canada represents; the second is the restriction on the introduction of new varieties imposed by our licensing system. On the basis of the experience of other countries with PBR, it would also be expected that private sector investment would not be uniform across crops or geographic areas.

While it is felt that there is no great benefit to be derived from the introduction of PBR, neither is there any great danger in its implementation, provided a number of safeguards are assured. They include:

1. An unyielding federal or provincial commitment to maintain or increase the present level of public plant breeding, including variety development. Such a commitment would ensure that even if increased concentration led to a decrease in competitive pressures in the private sector of the seed industry, the public sector would still provide a strong competitive force which would assure the availability of new varieties at a reasonable price.

2. An in-depth study of the seed industry both to determine the role played and the market share controlled by some of the larger corporations which have recently entered the seed industry, as well as to facilitate continued monitoring of the situation. This study would include the generation and collection of the basic data required to identify structural changes which may occur because of the introduction of PBR into Canada.

3. Guarantees that germ plasm exchange will be maintained at current levels or expanded. This is a particularly difficult area in that it requires the assurance of information flows; detailed procedures for achieving this safeguard would have to be formulated.

4. Guarantees that modification of the variety licensing system will be allowed even if PBR is introduced. Although this is a separate issue, the licensing system should not be tied to the introduction of PBR. Unfortunately, some pronouncements by Agriculture Canada seem to indicate that the introduction of PBR will be accompanied by a commitment to maintain the current licensing system intact in all its forms.

In keeping with this study's recommendation that a strong public effort be maintained in plant breeding, the authors suggest that if PBR is adopted in Canada, royalties should not be charged on protected public varieties. The reason for this conclusion is simply that since public monies supported the research which gave rise to the new varieties, charging the users a royalty on these new varieties would in effect be asking users to pay twice. However, if royalties are charged, it is strongly recommended that a uniform policy be adopted by all public institutions *not* to channel royalty funds into general revenues, *but to use them to support more plant breeding research*. This is a "second-best" solution, but one which might help ensure the necessary public support for plant breeding.

One additional recommendation: if PBR is implemented, serious consideration should be given to having the system administered by the Commissioner of Patents, Bureau of Corporate Affairs, Consumer and Corporate Affairs Canada. Although this responsibility might entail some technical problems initially, the authors are of the opinion that PBR is sufficiently similar to patents that the two systems should be administered within the same organization. The important public component of any intellectual property right granted by government is the exclusivity of production or trade which such a right confers; the product charac-

teristics or sector employing the product, are, at best, secondary considerations. Therefore, it seems logical for PBR to be administered together with all other intellectual properties.

Finally, since the current evidence indicates that there is neither a strong need nor great benefit to be derived, it is recommended that PBR be implemented only if *net benefits* to Canada can be *demonstrated* clearly. The authors have not been able to produce such evidence in the course of the present study.

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INTRODUCTION

In May of 1980, Bill C-32 (the Plant Breeders' Rights Act) was introduced (32nd Parl., 1st sess.) to provide for a system of plant variety protection (PVP) or Plant Breeders' Rights (PBR) in Canada.[1] Both before and after presentation of Bill C-32, there had been a great deal of debate on the effects of such legislation on the Canadian seed industry in general, and on plant breeding activity in particular. While the debate has centred on what are essentially economic considerations, the presentation of arguments, both positive and negative, has tended to be more emotional than logical, with very little attention paid to an economic analysis of the situation.

A review of the literature on PBR revealed that very little analysis of any kind has been done on the effects PBR has had in countries where it has been in existence for well over a decade. Only in the United States does there appear to have been interest in an ex post examination of the effects of PBR. This interest was sparked by Congressional hearings on minor amendments to the Plant Variety Protection Act (PVPA), which were held in July 1979 and April of 1980, and has resulted in three studies which are either currently in progress or not as yet available to the public. Thus, while there are diverse opinions about the effects of PBR, there is no systematic evidence available to confirm or deny the assertions of those who favour or oppose PBR.

RESEARCH OBJECTIVES

The primary aim of the research undertaken was to redress the lack of economic information on PBR in Canada. The study was intended to provide analysis and information, and to determine what additional data must be collected for a more thorough evaluation of PBR. Specifically, the research was directed toward analyzing the commonly promoted positive and negative aspects of PBR. For example, it is said that:

1. PBR would give rise to more private investment in plant breeding, which in turn would lead to the availability of more and better varieties to growers;

2. such rights would ensure that the best varieties produced world-wide are available to Canadian growers;

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1. Although there is some variation among countries, PBR essentially comprises a system of patent-like protection which is afforded to the breeders or discoverers of "new" varieties of plants.

3. royalties would accrue to Canadian plant breeders from foreigners using new Canadian varieties;

4. seed prices would increase;

5. royalties paid by Canadians using new foreign varieties would negatively affect Canada's balance of payments;

6. multinational firms would become a significant, if not dominant, force in Canadian plant breeding and distribution, and as a result the market would experience more concentration and less competition;

7. multinational profits would flow out of Canada, negatively affecting Canada's balance of payments;

8. if the current system of public testing of new varieties were maintained, the cost of administering PBR could be very high;

9. there would be an increased risk of "genetic vulnerability";

10. public plant breeding activity would eventually decline or at least be directed away from variety development to more basic research; and

11. the exchange of information and germ plasm among plant breeders would be adversely affected.

The emphasis of this study in these areas was to attempt to identify the major structural changes likely to occur as a result of PBR, and the consequent changes in the competitiveness of the plant breeding and seed distribution trade. The scope of the study was limited to the major grains and oilseeds produced in Canada.

METHODOLOGY OF THE STUDY

Because of the lack of published economic analysis or appropriate data, a descriptive policy analysis approach was employed. While there is no doubt that the framework of more formal cost-benefit analysis would have been more desirable, it was necessary to identify the important potential benefits and costs of PBR first, through an examination of the expected changes in plant breeding activity as well as in the remainder of the Canadian seed industry. Since interest in seed companies has recently been shown by some of the same multinationals that control the pharmaceutical industry, an examination of the structure of that industry was undertaken in the belief that it would provide valuable insight into the possible post-PBR structure of the Canadian seed industry. As well, since it was felt that the protection which PBR afforded plant breeders was analogous to the protection which inventors derived from patents, the Canadian experience with patent protection was

examined. Special attention was given to the effect of patents on research and development (R & D) in Canada, particularly in the pharmaceutical industry.

In addition, an attempt was made to identify changes that have taken place in the seed industries of countries which presently have PBR, with special attention given to the United Kingdom and the United States. We attempted to focus on the effects of PBR on the grains and oilseeds sectors in areas of the northern United States which have geographic and climatic conditions similar to the Canadian prairies to determine changes which are likely to apply to Canada when Bill C-32 becomes law.

In summary, the study proceeded by analogy, both in terms of the potential structural changes anticipated for the Canadian seed industry once PBR is in effect, as well as the effects these changes will have on the performance of the industry.

ORGANIZATION OF THE REPORT

This first chapter has served to introduce the study's research objectives and methodology.

Chapter II deals with Intellectual Property Rights in order to put the concept of PBR in context. As well, specific attention is given to the patent system and its effects on Canada in general, and on the pharmaceutical industry in particular. Special consideration is given to its effect on R & D activity. A brief description of the pharmaceutical industry in Canada is also contained in this chapter.

An examination of the present structure of the seed industry in Canada is the focus of Chapter III. A brief description of the seed industry in the northern United States is also included.

Chapter IV deals with PBR per se, giving a more detailed explanation of their stated positive attributes as well as the concerns which have been expressed about them. The experiences of the United Kingdom and the United States are highlighted, although the experiences of other UPOV member countries are also included. Finally, the prospects for Canada upon the introduction of PBR are examined.

Chapter II

INTELLECTUAL PROPERTY RIGHTS

THE NATURE OF INTELLECTUAL PROPERTY RIGHTS

Intellectual Property Rights (IPR) are granted for many forms of intellectual creativity. At present, in Canada, the following IPR are available: (1) patents, (2) copyrights, (3) industrial designs, and (4) trademarks. Briefly described, patents are granted for structure and function (i.e., product and process), whereas "*Copyright* is for literary, artistic, dramatic and musical works; *Industrial Designs* are for the shape, pattern, or ornamentation of an industrially produced object; and a *Trademark* is a word, symbol, or picture, or a combination of these used to distinguish goods or services of a person or organization from the goods or services of others in the market place" (CCAC 1977, p. 8).

The passing of the Plant Breeders' Rights Act (Bill C-32) would introduce a fifth IPR into Canada, that is, Plant Breeders' Rights. Of the four IPR described above, PBR most closely resembles patents. Patents are granted for products or processes that are new, useful, and inventive, or unobvious (ibid.). PBR would be granted on the basis that a new plant variety is distinct, uniform and stable (International Union for the Protection of New Varieties of Plants [UPOV] 1982, p. 16; Bill C-32, 32nd Parl., 1st Sess., s. 4). The basic difference between a grant of patent and a grant of PBR is that no inventive step is required in the latter. Thus, the discoverer of a "new" variety can appropriate nature's handiwork by merely finding it.[1] Like the grant of a patent, the grant of PBR confers on the grantee the exclusive right to exploit a new variety or to license others to exploit it (CCAC 1976, p. 8; Bill C-32, s. 22) for a specified period of time (CCAC 1976, p. 12; Bill C-32, s. 20). A provision similar to one under Canadian patent law in Bill C-32 would allow the issue of compulsory licences if it is deemed that the holder of the right is abusing it to the detriment of society (Bill C-32, s. 25; Patent Act, R.S.C. 1970, c. P-4, s. 41). While there

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1. A case may be made that discoverers of new varieties should be granted PBR on the basis that the discoverers of insulin were granted a patent for a product which they found intact in nature and used without modification. However, insulin "was considered patentable because of the unobvious and unexpected properties the insulin possessed for treating diabetes" (CCAC 1977, p. 8).

It should be noted that while Bill C-32 allows discoverers of new varieties to apply for protection, PBR legislation in other countries such as Australia "does not admit the inclusion of a variety which is simply discovered" (see Australia, Department of Primary Industry 1981, p. 3).

are other similarities and minor differences between patents and PBR, it is the granting of a government-sponsored monopoly in return for anticipated net social benefits which must be considered to be the most important feature of the two systems.

Because of the essential similarities between patents and PBR in terms of operation and intent, it was anticipated that an examination of the Canadian patent system would yield insights which would be readily analogous and thus transferable to the proposed system of PBR.

CANADA AND THE PATENT SYSTEM

Although the granting of patents has been part of Western civilization for more than 300 years and part of Canadian life since the early 19th century, there has been considerable debate over the efficacy of patents in achieving their intended social objectives. The position of those who favour the continuation of the system can be summarized as follows: patents induce inventive activity which might not otherwise be undertaken; and the benefits society derives by way of new products, processes and disclosed knowledge exceed the costs that monopoly may impose on society. Those opposed to patents contend that competition among firms is sufficient incentive to inventive activity, that know-how, or trade secrets, are sufficient protection, and that the obstacles which patents put in the way of competition involve social costs exceeding any benefits of the system (Machlup 1958, pp. 79-80). With few exceptions, both sides have relied on "the *a priori* logic of their case in the absence of substantial empirical evidence. Thus, discussion of these highly complex issues has tended to be inconclusive" (Mandeville and Lamberton 1981).

O.J. Firestone's 1973 study of the Canadian patent system indicated that a very high proportion of patents is granted to foreigners (95 per cent, including 70 per cent to American residents), the bulk of patents is held by a small number of large multinationals (mainly American), and that a very low proportion of foreign-owned patents is worked in Canada as compared to other countries (15.7 per cent, versus 51.5 per cent) (pp. 112-17). Firestone (1971) also found that "three-fifths of the R & D work carried on in Canada is proceeded with for good economic reasons, with patent protection being only a minor factor" and that although abolition of the patent system would be a disincentive for some R & D work in Canada, a number of the firms interviewed "would proceed with their R & D work in any event" (p. 169).

Another survey carried out by Andrew H. Wilson for the Science Council of Canada in 1970 reported that Canadian industry people felt that "patents play little or no part in the initiation of research programs or projects, but may play a much larger part in the initiation of development work" (as cited in CCAC 1976, p. 38).

A study by the Economic Council of Canada (ECC 1971) concludes that the patent system seems to operate against the interests of the Canadian economy:

> It is hard not to emerge from this analysis with the assessment that, as a means of encouraging industrial innovation in Canada, whether based on domestic inventions or in foreign inventions, plus rapid technological transfer into Canada, the existing patent system has not been an outstanding success. Looking at patents as an international system, there is a presumption that we are carrying too large a portion of the costs of the system in relation to...the benefits that we receive. (p. 81)

These sentiments are echoed by Firestone (1971): "Some of the disadvantages of the [patent] system have become more pronounced, reducing competition in the domestic market, limiting exports of certain articles and facilitating increased control of Canadian industry" (p. 320).

Although the studies of the Canadian patent system indicated that its net effects for Canada may be negative, studies in other countries have concluded that patents are a positive economic force,[2] or that they may have some positive benefits for selected industry groups. For example, an extensive study by Taylor and Silbertson (1973) concluded that patents had little effect on "the rate and direction of inventive and innovative activity undertaken by industry...except the secondary (non-basic) chemical industries. There, pharmaceuticals stand out as an industry in which at least one half of invention and innovation is heavily dependent on patent protection" (p. 346). However, the fact that patents induce invention or innovation is not a sufficient condition to ensure that the net effects of a patent system will be positive, as will be demonstrated in the following section.

THE COSTS OF PATENT MONOPOLIES

As stated earlier, the grant of a patent confers a monopoly upon the grantee in exchange for benefits which society is expected to derive. The existence of this monopoly, albeit qualified and limited by compulsory licensing[3] and other restrictive provisions, raises concerns about distortions in resource allocation which result in a reduction of

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2. See, for example, Banks 1970, p. 15; U.S. President's Commission on the Patent System 1966, p. 2.

3. The application of licensing and even compulsory licensing allows communication among industry members on prices and output which would otherwise be considered to violate anti-competition laws. See Priest 1977, pp. 313-15.

economic efficiency and productivity (Samuelson and Scott 1975, pp. 455-56). However, even if the direct benefits of the patent seem to outweigh the direct monopoly costs which are introduced, there may be other costs to society which must be considered.

The costs of administering the Patent Office may not be negligible when one considers the fees paid to the Patent Office directly, and to patent agents and lawyers acting on behalf of patent seekers. To this total must be added the costs associated with litigation over patent rights -- both direct legal fees for the parties involved and the cost of the court facilities (CCAC 1976, p. 12).

The duration of the patent is an important determinant of net social benefit. If the patent period is too short it will not serve to encourage invention and innovation; yet all the administrative costs will remain. If the period is too long, patentees will be protected from competition beyond the point where they have recouped all of their R & D expenses, but society will continue to pay a higher price for restricted output with no more benefits accruing. The long-run implications would be a tendency to discourage, or at least to impede, invention and innovation, since patentees reap benefits from old inventions or innovations (ibid.).

The scope of patents is important in that "broad" patents may induce investments which are viable only during the period of patent protection. This may lead to overinvestment in the short run. On the other hand, if the scope of patents is "narrow," there may be a tendency for others to try to "patent around" the original patent. This may give rise to too much duplication of effort (a cost which patents are intended to reduce through disclosure) as well as costly litigation to determine patent validity (ibid., p. 13).

Since patents increase the expected return from investment in inventive or innovative activity, investment theory predicts that there will be more capital investment in this activity (this increase is, of course, one of the *prima facie* reasons for having a patent system). As more inventions and innovations are produced, the number which are successful will undoubtedly increase, but so, most likely, will the number that fail. If the proportion of failures increases, the patent system may be responsible for an increased distortion of the market toward risky investment which would otherwise have been avoided (ibid., p. 14).

These last three costs may be attributed to what Beck (1980) refers to as competition for patent monopolies. To this list may be added the cost of innovating too soon, that is, producing inventions and innovations prematurely because of the fear that a competitor will capture the patent. This causes a loss in the maximum potential rent and "represents the transformation of wealth transfers into social costs. Such transformation causes resources to be misallocated at a cost equal to foregone rent" (p. 7). Such resource misallocation could conceivably decrease rent, that is, social benefit, to zero (ibid.).

From the preceding discussion, it is clear that evaluation of the patent system is a complex undertaking. There is considerable controversy concerning whether the patent system is producing the positive effects for which it was intended, and there is even disagreement about whether these supposedly positive effects create a net benefit for society. It is clear then that:

> In evaluating the net worth of the patent system, it is not sufficient simply to conclude that because it may encourage research or innovation it is necessarily beneficial to society. Rather it must be demonstrated that the system, whatever its form, serves to maximize the benefits and minimize the costs and that, moreover, the benefits exceed the costs in both the short and long run. (CCAC 1976, p. 15)

STRUCTURE, FIRM SIZE, R & D, PATENTS, INVENTION AND INNOVATION

Controversy exists about the relationship between industry structure, the amount of R & D undertaken and the success of that R & D effort. This is partly because it has proved difficult to construct useful measures of R & D inputs (expenditures, employees, etc.) and outputs (patents, inventions or innovations, major inventions or innovations), or to decide what aspect of structure to examine (e.g., concentration, firm size within the industry, etc.). As a result, the literature dealing with this subject is extremely fragmented and rather confusing, with definitive answers to the question of relationship between industry structure, R & D, and patents, inventions or innovations, extremely difficult to find (ibid.). A brief discussion of some of the work in this area at the industry and firm level follows.

As discussed in Kamien and Schwartz (1975), foremost among those associated with the position that some degree of market power and large size are needed spurs to inventive activity are Schumpeter (1950) and Galbraith (1952). They assert, without empirical evidence, that "the promise of monopoly power for a time creates the quest for it through innovation, while fear of its loss promotes continued innovation and adoption of new technology" (in Kamien and Schwartz 1975, p. 15).

In his study of the effect of industry structure on innovation, Maclaurin compared the important innovations of U.S. industries with their degree of monopolization (measured by the firm size of the industry price leaders and the ease of entry). He concluded that "while some degree of monopoly power is necessary for technological progress, it is not sufficient" (in Kamien and Schwartz 1975, p. 19).

More recent studies have used a concentration ratio, which employs the portion of sales by the 4, 8 or 20 (Cr 4, Cr 8, Cr 20) largest firms in an industry, as a measure of monopoly power rather than Maclaurin's measure. Horowitz (1962) found a weak positive correlation

between Cr 4 and research expenditure per industry sales dollar (pp. 298-301). Hamberg (1966) also found R & D per sales dollar and industry concentration to be correlated positively, but weakly. Scherer (1967) concluded that there was a significant positive association between industry concentration and intensity of research effort, which reaches a peak at Cr 4 of 50 to 55 per cent (p. 524). Similar results were obtained in a study by Kelly, who found that maximum research intensity appears to occur with Cr 4 at 50 to 60 per cent (as cited in Kamien and Schwartz 1975, p. 21).

In a study using Belgian data, Phlips (1971) concluded that concentration had a significant influence on research intensity only in those industries, such as the chemical industry, with the greatest technological opportunity, that is, where research is most intensive (pp. 119-42). In a study of the number of industry-related patents issued to the leading four firms in an industry, Scherer (1965a) found no support for the hypothesis that innovative output tends to increase with increased industry concentration (p. 1121).

Williamson (1965) found that the influence of concentration on innovation in the four largest firms in an industry was negative. That is, the relative share of innovations by the largest firms appeared to decrease with increased monopoly power, such that with Cr 4 above 30 to 50 per cent, the largest firms appear to supply less than their proportionate share of innovations (pp. 67-73).

In considering another element of market structure, ease of entry, Comanor (1967) concluded that when entry barriers are either very low or very high, the incentive for research may be substantially less than at some intermediate level (pp. 639-57).

In a study of the effect of rivalry on R & D effort, Grabowski and Baxter (1973) found some support for the hypothesis that R & D expenditures respond positively to a rival's R & D expenditures, especially between the two leading firms in an industry. They also found a positive correlation between increased concentration and conformity in R & D expenditure among firms. This does not, however, imply that high concentration leads to high levels of R & D -- industries with little or no R & D also display conformity among their members in this regard (pp. 209-35). A study by Globerman (1973) of the relationship between concentration and technological opportunity and R & D effort in Canadian manufacturing industries found that in industries with greater technological opportunity, research intensity varied inversely with concentration (pp. 59-67).

Data availability has allowed more extensive investigation of the relationship between R & D effort (output) and firm size than between R & D effort and market structure. A commonly tested hypothesis is that R & D activity increases more than proportionately with firm size. Early studies by Horowitz (1962) and Hamberg (1966) indicated at best a very weak positive relationship between R & D effort and firm size.

Worley (1961) and Comanor (1967) found a significant relationship between R & D intensity and firm size in only a small proportion of the firms they studied. Scherer (1965b, pp. 256-66) found the relationship between firm size and R & D effort had an inflection point; that is, R & D effort generally increased faster than firm size among smaller firms, but more slowly among larger firms. He noted, however, that the chemical industry appeared to be an exception in that R & D intensity appeared to rise with sales. Studies by Mansfield (1960) and Grabowski (1968) confirmed Scherer's findings, including the anomaly of the chemical industry. Reviewing previous literature, Markham (1965) also concluded that inventive effort tends to increase more than proportionately with firm size up to some point, which varies from industry to industry, and then appears to remain constant or decrease with increasing size (p. 329).

Using patents as a proxy for average inventive output, Scherer (1965a) found that smaller firms were responsible for a higher relative share of inventive activity in proportion to sales and that patent output generally increased less than proportionately with sales among large corporations (p. 1120).

Canadian studies of the relationship between innovation and firm size have been concerned mainly with the determinants of R & D expenditures. A study for the Royal Commission on Corporate Concentration (RCCC 1976) found that R & D effort increased with size, and that in some industries (electrical and some chemical products), R & D increased more than proportionately with size up to a certain point (i.e., sales in excess of $200 million) and then declined (p. 59). In another study for the RCCC, McFetridge found that some larger firms seemed to make better use of a given R & D budget than smaller firms, as measured by patent activity (reported in RCCC 1976, p. 59). This result seems to run counter to the prevailing view in the literature.

To summarize the relationship between R & D intensity and firm size, it appears that, with the notable exception of the chemical industry, R & D activity, whether measured by inputs or outputs, increases with firm size up to a certain point and then levels off, or even declines with further increases in firm size. Studies of industry structure and R & D have generally used the industry concentration ratio as a measure of monopoly in an industry. Little support has been generated for the standard hypothesis that R & D effort increases with the degree of monopoly power. Rather, it appears that an industry structure occupying a position between monopoly and perfect competition may give rise to the greatest amount of R & D effort (Kamien and Schwartz 1975, p. 32). The results of these studies can at best be described as tentative; consequently the policy implications are also tentative:

> One conclusion relevant to public policy follows immediately. No single firm size is uniquely conducive to technological progress...[and] the main lesson to be drawn from a review of the...evidence is that no single, one-

> to-one relationship between [industry] structure and technological progressiveness is discernible...[Yet] it seems clear...that market concentration has a favourable impact on technological innovation in certain situations. (Scherer 1980, pp. 432, 437)

What also seems clear from these studies is that an examination of industry structure alone is not sufficient to explain the level of R & D in an industry. Other factors which might be considered to influence R & D expenditures, in conjunction with structure, include the characteristics of the industry's product(s) as well as the demand characteristics of the market for that product.

THE PHARMACEUTICAL INDUSTRY IN CANADA

> To a very considerable extent, the Canadian [pharmaceutical] industry is dominated by subsidiaries of multinational firms with headquarters in other countries. Their operations are frequently restricted to servicing the Canadian market by formulating imported active ingredients into final dosage form. This has tended to rather severely limit the extent of basic manufacturing, the level of new product research and development, and export performance. (LeNeveu 1981, p. 5)

As this quotation suggests, the pharmaceutical industry in Canada is characterized by fairly high concentration and almost complete domination by foreign owners in terms of value of sales. In 1974, the top 12 firms accounted for over 50 per cent of the industry's sales (Statistics Canada 1978, p. 105), while 84.7 per cent of total pharmaceutical market sales by value were supplied by foreign owned companies in 1973 (Palda and Pazderka 1980, p. 61). Entry into the industry is not easy because of high start-up costs, which are due in part to the necessity of extensive testing to satisfy regulatory requirements and the widespread use of patents by existing firms.

From the above description of the industry, it is not unreasonable to conclude that the Canadian pharmaceutical industry is oligopolistic in nature. Some of the concerns that such a structure generates include the pricing-output policy and attitude toward technological change displayed by the members of the oligopoly.

A wide variety of pricing-output alternatives may exist in oligopolistic industries, ranging from those that would exist under perfect competition at one extreme, to monopoly at the other. Firms may engage in cooperative behaviour or extreme rivalry which ends in ruinous price wars. The latter may result in a decline in the total revenue, and hence total profit in the industry without appreciably affecting market shares. Therefore, economists predict that firms in an oligopolistic industry will tend to maximize total industry profit by approximating

the pricing behaviour of a price monopolist and will compete in areas other than prices once a satisfactory stable price level has been reached (Samuelson and Scott 1975, pp. 469-72).

The most common types of pricing behaviour exhibited in oligopolistic industries include: (a) price leadership (where one firm takes the lead in raising or lowering prices and other firms follow its lead); (b) the dominant firm (where one firm is large both in absolute terms and in relation to other firms in the industry and can "within broad limits choos[e] its rate of profits (or its share of the market) undeterred by the consideration that rivals may compete away these profits by offering better terms to customers" [RCCC 1976, p. 81]); and (c) conscious parallelism (where the leading firms in an oligopoly are aware of their interdependence and are able to coordinate their actions in response without outright collusion among themselves [ibid, pp. 79-88]). Given the presence and widespread use of the patent system (which effectively serves to eliminate the constraint on pricing of "poised competition"),[4] it seems reasonable to expect that the pricing behaviour exhibited in this market would most closely resemble the dominant firm model, with the dominant firm being a function of who holds the patent for the various chemical entities. That is, the patent holder of an important drug would determine the price and market share available to licensees for the duration of the patent. Once an important product moves out of patent and becomes multisource, it is possible that intense price rivalry would be initiated by competitors (Schwartzman 1977, p. 251). A case may be made, however, that brand differentiation may remain a sufficiently strong force to maintain the position of the dominant firm even after expiry of the patent.

The existence of compulsory licensing, as well as legislation in most provinces, which allows or compels pharmacists "to dispense lower priced, generically equivalent drug products unless the physician specifies 'no substitution'" (Ellis n.d., p. 4), has served to curb the unnecessarily high prices for pharmaceuticals in Canada to some extent. The dominant firm model still appears to hold, however, at least in the diazepam market (ibid., pp. 1-25), and although there is no substantive proof, there is reason to believe that this pricing model applies to other important drug products as well.

Concern about the innovative performance of the Canadian pharmaceutical industry arises from the prevalence of foreign ownership as well as the level of industry concentration. LeNeveu (1981) contends that very little new product R & D effort takes place in Canada because the multinational pharmaceutical companies tend to concentrate this activity either in their home market or in other large market areas. He goes on to state that most of the R & D activity which has taken place

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4. "Poised competition" refers to a situation where new firms will enter an industry if there is sufficient economic incentive.

in Canada has been "largely aimed at clearing product regulatory requirements for products developed elsewhere, rather than...[being] designed to ensure creation and commercialization of new products in Canada" p. 8; see also Gordon and Fowler 1980, p. 13).

A study comparing the R & D intensity of the Canadian pharmaceutical industry with that of other OECD countries (Palda and Pazderka 1980) found that R & D intensity was positively related to the concentration of the industry and the degree of patent protection, and negatively related to the degree of foreign ownership in the industry (p. 52). This last finding lends support to LeNeveu's contention that the Canadian subsidiaries of multinational pharmaceutical companies serve mainly as distributors for products developed elsewhere. Data employed by Palda and Pazderka show that while Canada produced 2.6 per cent of the total pharmaceuticals manufactured in OECD countries in 1977, it was responsible for the introduction of an estimated 0.5 per cent of new chemical entities between 1958 and 1970 (Table 11, p. 76; Table 14, p. 82). Thus, the findings of Palda and Pazderka seem to indicate that the oligopolistic structure of the pharmaceutical industry in Canada may enhance its R & D effort, while the large degree of foreign ownership[5] and the existence of compulsory licensing act as disincentives to inventive activity in this country (pp. 52-54).

In contrast to the assertions of Palda and Pazderka, and a number of other studies,[6] Gorecki (1981) found that the view that compulsory licensing has led to a substantial decrease in pharmaceutical R & D investment "is not consistent with the available data. Indeed, the weaker inference that R & D has declined is not supported" (p. 161). According to Gorecki current and capital R & D expenditures in Canada, in constant terms, have not decreased since the advent of compulsory licensing. In fact, "when industry size is taken into account, R & D (measured by current or capital expenditures as well as employment) has been virtually unchanged since 1967" (ibid.). While Gorecki concedes that it is not an incentive to R & D investment, he rejects the assertion that compulsory licensing has led to a decline in R & D in Canada based on the fact that no hard evidence has been provided which conclusively links decreased R & D with the advent of compulsory licensing.

From this brief description of the pharmaceutical industry in Canada, it appears that because of the high degree of foreign control, the industry serves more of a distribution function than an innovative one. The widespread use of patents for the various chemical entities

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5. A recent study by Rugman, although not dealing specifically with the pharmaceutical industry, found support for the proposition that less R & D is done in the branch plants of multinationals in Canada than in either their home market or in independent Canadian firms of similar size. See Rugman 1981, p. 613.

6. See, for example, OECD 1977, and Industry, Trade and Commerce 1979.

which the industry produces has led to a significant increase in the monopoly characteristics displayed by the industry. This, in turn, has given rise to unnecessarily high drug prices. The introduction of compulsory licensing is viewed to have mitigated the situation somewhat for drugs with widespread distribution, but has had little effect on the price of drugs with a limited market.

Chapter III

THE SEED INDUSTRY: CANADIAN AND U.S. PERSPECTIVES

INTRODUCTION

The seed industry can be divided into two areas of endeavour, plant breeding and distribution. In the past, commercial plant breeding in agricultural crops has been concerned with improving the yield and nutritional potential of field crops. At the same time, breeders have attempted to provide new varieties with increased resistance to insects and disease as well as the meteorological vagaries of nature. The distribution system includes the multiplication of seed as well as the marketing system which places the seed into the hands of the final user, the farmer. Superimposed upon both parts of the seed establishment, both in Canada and the United States, are regulations which, at least in Canada, play a significant role in determining the behaviour of many participants in the seed industry. Despite the importance of this industry to agriculture in both Canada and the United States, very little information is available on its structure and operation in either country.[1] This lack of information, and a basic lack of data, prevented a careful analysis of existing structure and structural changes as part of this study and represents a serious deficiency in the ability to detect or monitor the effects of PBR if it were introduced.

PLANT BREEDING

Canada

In Canada, plant breeding of cereal cultivars has historically been a public sector activity and it is only recently that the private sector has become more involved. Although no exact figures are available, the concensus is that the public sector accounts for at least 95 per cent of all plant breeding done in this country. Prior to 1978, all breeding for cereals and oilseeds was conducted by public breeders. Currently, the Alberta and Saskatchewan Pool Elevator Companies have a breeding program for wheat, oats, barley, rapeseed, and most recently, for hybrid sunflowers, while Ciba-Geigy Seeds has a wheat breeding program. However, the majority of private sector breeding activity is centred on hybrid corn and market-garden crops.

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1. An extensive review of Canadian data sources, the Canadian economic literature, and personal communication with industry members confirmed that little information on the industry was available, and that certainly no comprehensive studies had been done. Robert F. Liebenluft found the same situation existed in the United States. See Liebenluft 1981, p. 86.

Within the public sector, it is estimated that Agriculture Canada accounts for approximately 67 per cent of the breeding effort, while universities provide the remaining 33 per cent. In a more detailed breakdown of the research effort, it is estimated that 60 per cent of university breeding programs are directed toward basic research and 40 per cent are devoted to more applied research (that is, varietal development), while the reverse is true for Agriculture Canada. At present, no estimate of the distribution of research effort among private firms is available. It is known, however, that 100 per cent of their research is directed to varietal development.[2]

Plant breeding activity in Canada is constrained by a licensing system which requires phenotypic distinguishability for a new variety as well as improvement in at least one quality attribute (yield, disease resistance, pest resistance, etc.) while other quality standards are still maintained. A second difficulty imposed on breeders is that new varieties must be licensed for all of Canada, and cannot be adapted and licensed only for certain geographic regions.[3]

United States

The history of cereal breeding in the United States is similar to that in Canada in that most early research was carried out by the public sector, generally at agricultural experiment stations. It is only with the advent of hybrid varieties that private companies became interested in setting up their own plant breeding programs, rather than just distributing the varieties which were developed by public plant breeders. The reasons for this increased interest were twofold. First, the quality of hybrid seed is a function of its inbred parents and grandparents. Since it is virtually impossible to determine the inbred crosses which produced the hybrid by simply examining the seed, private companies can maintain exclusive control over their hybrids by simply maintaining the secrecy of their hybrid lines. Second, unlike self-pollinating crops, where farmers can save their own seed to use in subsequent years without significant loss in crop yield or quality, the superior vigour displayed by hybrid seed is not present in its offspring. Thus, farmers must purchase seed each year if they wish to retain the yield advantages of hybrids.

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2. These estimates were derived in part from personal communication with Dr. W. Bushuk, Vice-President (Research), University of Manitoba, and in part from information released by Agriculture Canada, in mimeographed form, which specifies that of the 144 plant breeders employed in the public sector in 1980, 97 were employed by Agriculture Canada and 47 by universities.

3. There is some evidence that this universality requirement is in the process of being relaxed. However, these constraints remain as important regulatory factors in plant breeding.

While hybrid corn was the first and by far the most successful of the hybrids, private companies have attempted to produce other hybrid varieties. To date, they have been most successful with sunflower, sorghum, cotton and a number of vegetable varieties. Despite extensive continuing research to develop cereal hybrids, especially a wheat hybrid, the private sector has been unable to produce hybrids that are significantly better than non-hybrid varieties which are presently available.

Although no figures are available, it appears certain that relatively more private plant breeding activity is taking place in the United States than in Canada. Institutional differences between the two countries include the passage of the U.S. Plant Variety Protection Act (PVPA) in 1970. The PVPA attempted to provide breeders of non-hybrids with legal protection, which was equivalent to the protection that existed for hybrids. An assessment of the impact of the PVPA on U.S. plant breeding will be provided below. A second difference is that there are no licensing provisions in the United States, so that American plant breeders are less constrained than Canadians in their efforts to produce new varieties.

SEED DISTRIBUTION

Canada

The Canadian seed distribution network comprises two distinct yet interrelated parts, that is, seed multiplication and commercialization. The multiplication of pedigreed seed from Breeder to Certified is carried out by members of the Canadian Seed Growers Association (CSGA). The plant breeder who originated the variety provides the CSGA with a small amount of Breeder seed, which is then multiplied through two generations by CSGA members who are designated Select Breeders to produce Select and then Foundation seed. Foundation seed can then be multiplied by all members of the CSGA to produce Registered and then Certified seed. It is this latter type that is sold in commercial quantities to farmers to meet the food and feed demand for a particular variety.

Seed is multiplied under strict growing conditions required by the CSGA to ensure purity and identity. To minimize the possible effect of genetic shifts or contamination, the number of generations of seeds produced from Breeder or Select seed that are considered pedigreed is limited. Thus, growers must obtain a new stock of Foundation or Registered seed at specified intervals in order to continue to grow pedigreed seed.

Pedigreed seed must meet certain standards of germination and must not contain excessive amounts of weed seeds, seeds of other crops or inert matter. Enforcement of these standards is the responsibility of the Plant Products and Quarantine Division of Agriculture Canada. Once pedigreed seed passes inspection, labels are attached to the bags

containing it, indicating its class of pedigree, its crop and variety names, the crop certificate number assigned to it by the CSGA, which identifies the grower, the year it was produced and the seed certificate number assigned by Agriculture Canada for each lot of seed tagged by a seed inspector. For ease of identification, each class of seed has a different and easily distinguishable tag colour.

After 1976, the SeCan Association[4] became involved in the multiplication and merchandising of new varieties exclusively by members of the new association. Thus many members of the CSGA became members of SeCan so they could grow new varieties which were released through SeCan. In accordance with the rules of the CSGA, SeCan members agree to produce only pedigreed classes of seed. They also agree to sell only the Certified class of any variety, except to other SeCan members.

Unlike the CSGA, SeCan Association charges a levy of 2 per cent on the sale price of Certified seed only and collects any royalty which the plant breeder, who releases a variety through SeCan, chooses to impose. To date, most SeCan variety releases have been from Agriculture Canada, which *does not* impose a royalty, and from universities, some of which do ask for a royalty and some of which do not. Although, at present, the number and importance of varieties released through SeCan is still relatively small, it is anticipated that SeCan will become an increasingly important force in the Canadian seed industry, both in the multiplication and distribution of pedigreed seed.[5]

In Canada, pedigreed seed is distributed mainly through the line elevator companies, such as the Pools, and through smaller local seed firms, many of whom are also seed growers and processors. As with seed growers, many traditional distributors of pedigreed seed are now also members of SeCan so that they can distribute varieties released exclusively through that organization. One of the functions SeCan performs is to promote new varieties through media releases and commercial advertising campaigns.

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4. "SeCan membership is open to anyone who has access to facilities for multiplication, processing, storage and merchandising of seed. Essentially, this means that anyone who has an interest in seed and is willing to pay the annual fee [of $100], can join and participate in varieties." (Extract from talk by L.R. White, President, to the Joint Meeting of the Western Seed Growers and Seed Trade, October 30, 1979, in Winnipeg, the SeCan Association, Ottawa, p. 4). Thus, SeCan membership includes plant breeders, seed companies, government agriculture officials (both federal and provincial) and seed growers.

5. Membership in SeCan more than doubled between December 1979 and December 1980, rising from 328 to 763 members.

Although increasing, it is estimated that only about 20 to 30 per cent of the seed used in Canadian agriculture is pedigreed, and this varies considerably depending on the crop in question. The distribution of non-pedigreed seed is generally on a farmer-to-farmer basis. Recent changes to the Seeds Act do not permit advertising of seed for sale by variety name, unless the seed is pedigreed. Non-pedigreed seed can only be advertised by generic name (wheat, oats, barley, etc.). These changes were intended to increase the sale of pedigreed seed.

United States

As in Canada, the United States seed industry can be divided into separate but interrelated multiplication and distribution systems. Unlike Canada, the United States has no licensing system; therefore there is no restriction on varieties which can be grown. The major regulatory instrument used to encourage the use of the best available seed and to make available high quality seed is the certification program which is the responsibility of each state. Authority for implementation of the program is generally delegated to the State Agricultural Extension Service, or more often to a crop improvement association. In order for a variety to be certified, the originator, or his or her other agent, must submit certain information including: the variety name; information on its origin and the breeding procedure used in its development; a description of the plant and seed of the variety (both morphological and physiological) that distinguishes it from other varieties; evidence of the performance of the variety (e.g., comparative yield data, insect and disease resistance, etc.); a statement delineating the areas of adaptation of the variety; a statement indicating how the seed stock classes will be maintained, including the number of generations through which the variety may be multiplied; and a seed sample (North Dakota State Seed Department 1980, pp. 1-2).

There are only four pedigree classes in the United States: Breeder, Foundation, Registered and Certified. As in Canada, Breeder seed is controlled by the originating plant breeder or institution, while Foundation seed must be owned by or multiplied under the supervision of an agricultural experiment station, or the originating plant breeder or institution.

There is no equivalent to the CSGA in the United States. Any grower can produce Registered or Certified seed provided that the seed is produced, handled and distributed in accordance with the certification rules set down by the state. The originating plant breeder can specify the number of generations through which a variety can be multiplied; however, to minimize the possibility of genetic drift or contamination, only two generations beyond Foundation seed are usually allowed. Thus, like members of CSGA, American growers must replenish their planting stocks at specified intervals.

The certifying agency is responsible for inspecting pedigreed seed to ensure that it meets certain standards of germination and levels of impurities allowed. As in Canada, tags must be attached to packages containing pedigreed seed. These tags indicate the class of Certified seed, the state in which the seed was certified, the crop and variety name, and a number which can be used to trace the grower and certification records of the particular lot of seed (Liebenluft 1981, p. 92).

Although certification does not ensure that a particular variety meets any quality or yield standards, it does ensure that the quality and purity of the seed itself are high. In addition, although there is no absolute guarantee that advertising claims for the properties of the variety will not exceed its performance, certification provides a mechanism to ensure that the advertised claims do not exceed the variety's performance in reported test trials. Certification thus provides U.S. farmers with some of the protection which the licensing system provides to Canadian farmers.

The seed distribution channels in the United States are similar to those in Canada. Pedigreed seed moves through farmer co-operatives, elevator companies, and many small local processing firms, many of which produce pedigreed seed as well. In addition, a number of seed companies breed, multiply, process and distribute their own seed (e.g., Pioneer, Jacques Seeds, etc.).

As in Canada, the majority of seed used by U.S. farmers is non-pedigreed, the exception being hybrid seed. As such, much of the seed sold is non-certified, which means there is little or no quality control over the seed itself. However, the enactment of the PVPA in 1970 has led to an increase in the number of new varieties which are being certified, for reasons which will be discussed below, and it is expected that this trend will continue.

RECENT DEVELOPMENTS

Although there is a dearth of explicit information about participants in the seed industry in Canada and the United States, it is clear from the discussion above that the industry in both countries is fragmented and thus relatively competitive. This is especially true in the growing and distribution of self-pollinated cereal crops, but is less true in hybrids, especially in hybrid corn. The plant breeding effort in both countries is shared by both the public and private sector, although the relative shares have been changing.

Despite the relatively dispersed nature of the seed industry in both countries, a number of developments have raised concerns about the possibility of increased anti-competitive behaviour. The primary cause of this concern is the acquisition of seed companies in both Canada and the United States by large multinational pharmaceutical, petrochemical and food processing firms (see Table 1 for recent takeovers of Canadian companies and Table 2 for U.S. companies). While the number of acquisitions appears to be fairly large, it is impossible to know what their impact is or will be. This is due to the lack of information available about the market share which these seed companies have, both in Canada and in the United States.

The growing financial constraints faced by public breeding programs are another cause for concern. It is feared that if public input into varietal development is curtailed or eliminated, private companies will raise seed prices unduly once they have a monopoly or near-monopoly in the introduction of new varieties.

A development which thus far affects only the United States is the existence of plant variety protection (PVP) in that country. Its effect on the U.S. seed industry is fully discussed in the next chapter.

The emergence of SeCan in Canada has created concern in the U.S. plant breeding community because of the apparent reluctance of this Canadian organization to provide breeding material of varieties for which it has exclusive right of release. If this is, or continues to be, the case it may curtail the traditionally open reciprocal flow of information and materials between U.S. and Canadian plant breeders.

Table 1

Recent Takeovers and Holders of Canadian Seed Companies

Acquirer (A) or Holder (H)	Canadian Seed Company
Cargill Grain (A)	Kroeker Seeds Mighty Peace Grain Limited -- Seed Division
Celanese Corp. (A)	Harris Seeds
Ciba-Geigy (A)	Stewart Seeds Limited Hybridex Inc. Funk International Seeds Canada Ltd.
Continental Grain (A)	Hannas Seed Company
Dekalb Agresearch U.S.A. (H)	Dekalb Canada Limited
Maple Leaf Mills Limited (A)	Maxville Feed and Seed Ltd.
Norin Corp. (H)	Maple Leaf Mills
Pfizer Chemicals and Genetics Ltd. (A)	Warwick Seeds Limited
Pioneer International Inc. U.S.A. (H)	Pioneer Hi-Bred Corn Co.
Sandoz (A)	Northrup-King Co. National NK Seeds Ltd.
Upjohn Pharmaceutical (U.S.A) (H)	Asgrow Canada Ltd.
W.R. Grace (H)	Pfister Hybrid American Breeder Service
Yoder Bros. Inc. (A)	Yoder-Atkin-Ltd.

Source: FIRA 1974/75-1982/83.

Table 2

Recent Acquisitions of U.S. Seed Companies

Acquirer	Seed Company
Agrigenetics	Keystone Seed Jacques Seed
Anderson Clayton	Paymaster Farms Tomeo-Genetic-Grant
Cargill	Dorman Seeds Kroeker Seeds PAG
Celanese	Cepril Inc. Moran Seeds Joseph Harris
Central Soya	O's Gold Seal
Ciba-Geigy	Funk Seeds International Stewart Seeds Louisiana Seed
Diamond Shamrock	Taylor-Evans Seed Co.
FMC Corp.	Seed Research Association
Garden Products	Gurney Seeds
General Foods	Burpee Seeds
Hilleshoeg/Cardo	International Forest Seeds Co.
International Multifoods	Baird Inc. Lynk Bros.
International Telegraph and Telephone	O.M. Scott and Sons
Kent Food Co.	L. Tewles Seed Company
Kleinwanzieberer Swatzucht AG	Cooker's Pedigreed Seed Company
Monsanto	Farmers' Hybrid Co.

Table 2 (cont.)

Acquirer	Seed Company
National Association of Plant Breeders (Olin & Royal Dutch Shell)	Agripo Inc. Tekseed-Hybrid
Occidental-Petroleum	Ring Around Products
Pioneer Hi-Bred	Lankhart Lockeet Arnold Thomas Seed Co.
Pfizer	Clemens Seed Farms Jordan Wholesale Co. Trojan Seed Warwick Seeds
Purex	Advanced Seeds Ferry-Morse Seeds Hulting Hybrids
Sandoz	National N.K. Northrup-King Rogers Bros.
Southwide Inc.	Delta and Pine Land Greenfield Seed
Tate & Lyle	Berger & Plate
Tejon Ranch Co.	Waterman-Loomis Inc.
Upjohn Pharmaceutical	Asgrow Seeds Associated Seeds

Source: Claffey 1981, p. 32; U.S. Congress 1979, p. 53.

Chapter IV

PLANT BREEDERS' RIGHTS

THE LITERATURE

In favour of PBR

As mentioned above, PBR is a system whereby patent-like protection is granted to the developers or discoverers of "new" varieties of plants. The reasons often cited for its adoption include the following: (1) it will encourage the development of new varieties of plants, especially through more private sector investment in plant breeding; (2) it will ensure the best varieties are available to domestic growers; (3) royalties collected on new varieties could be used to defray the cost of public plant breeding; and (4) equitable treatment for plant breeders; that is, like others working in the area of intellectual properties, they deserve to reap some of the reward from their own efforts.

Despite a concerted effort, an extensive search of the literature uncovered only four quasi-empirical studies to determine the accuracy of any of the stated claims about PBR. A 1976 survey sponsored by the American Seed Trade Association (ASTA) indicated that 71 per cent of the responding companies had increased their plant breeding research effort due to the existence of plant variety protection (PVP), while 29 per cent stated that it had no effect on their research expenditure.

In an examination of some of the effects of PBR on the United Kingdom, Murphy (1981) found that there has been a large increase in the number of new varieties being protected, including many new cereal varieties since 1965. As well, the number of private firms engaged in plant breeding has increased from about 10 in 1967 to 23 in 1981.[1]

Corresponding to this, investment in private sector plant breeding has increased sharply in the United Kingdom. Although no exact figures are available, the British Association of Plant Breeders collected data which indicated that there had been a 500 per cent increase in private plant breeding investment between 1975 and 1980 alone. In addition, Murphy (1981) indicates that private varieties have improved substantially, especially during the mid to late 1970s.[2] He cites the fact that in spring barley, the most extensively grown crop in the United Kingdom, six out of nine varieties presently on the recommended list were bred by private sector U.K. breeders (p. 28).

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1. Unfortunately no figures are given for the number of new protected cereal varieties available.

2. Murphy does not specify what is meant by "improved."

Preliminary results of a study by Perrin indicated that there was an increase of over 4000 per cent in the level of investment in soybean breeding in the United States, as well as an increase in the level of cereal breeding of over 350 per cent between 1970 and 1979. Perrin also found that the rate of genetic improvement was greater after PVP, but that the increase was not statistically significant.[3]

The most recent study of PVP sponsored by the American Seed Trade Association (Batcha and Studebaker 1982), indicates that from the date of the inception of PVP until May 1982, there had been 964 PVP certificates issued. Of this total, 217 certificates had been granted for Soybeans, 104 for new Common Wheat varieties, 5 for Durum Wheat, 14 for new Barley varieties, and 12 for Oats (Table 1, p. 8). The study found that at the end of 1981, Americans owned 646 (72 per cent) of the certificates granted, and foreigners owned 195 (22 per cent), while 52 (6 per cent) were owned by persons or organizations of undetermined origin (Table 4, p. 10). In grouping PVP certificates by type of owner, the ASTA study found that, at the end of 1981, 393 (44 per cent) were owned by multinationals (U.S. and foreign), 249 (28 per cent) were in the possession of non-multinational private companies (U.S. and foreign), 130 (15 per cent) were granted to public institutions (U.S. and foreign), 54 (6 per cent) were owned by cooperatives (U.S. and foreign), 15 (1 per cent) were granted to individuals (U.S.), and 52 (6 per cent) were classified as owned by miscellaneous (U.S. and foreign) because ownership could not be determined (ibid.).

CONCERNS ABOUT PBR

Concerns expressed in the literature about the effects of PBR include: higher seed prices; more seed industry concentration; high PBR administration costs; increased risk of "genetic wipeout";[4] less public plant breeding activity or a shift away from variety development to more "basic" research; an end to or at least a slowdown in the exchange of information and breeding materials; and specifically in Canada: royalties paid to foreigners greater than incoming royalties; and multinational profits from seed companies flowing out of Canada.

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3. Personal communication, Richard Perrin, Department of Economics and Business, North Carolina State University, Raleigh, N.C.

4. Concern about genetic wipeout, genetic vulnerability, and lack of generic variability refers to the fear that increasing dependence on only one or two varieties of each crop (monoculture) leaves us more vulnerable to a single disease or insect pest which could destroy nearly all of a particular crop. The corn blight which destroyed a large percentage of the U.S. corn crop in 1970 is cited as an example of the danger of lack of genetic variability in the crops we produce.

A search of the literature revealed a number of quasi-economic studies which had analyzed some of the issues mentioned above. A study by Claffey (1981) examines the effect of PVP on the economic concentration in the seed industry as well as its effect on genetic variability. In evaluating the former, Claffey collected examples of recent seed company takeovers in the United States. Although they provide food for thought, Claffey states, "as evidence of supporting allegations of economic concentration...this is liable to be charged as being only circumstantial, since the intent of acquisition is not explicit and dates of acquisition are coincidental with passage of the PVA" (p. 32). She posits plausible reasons for the sale of U.S. seed companies other than PVP, such as the low value of the U.S. dollar in relation to European currencies in the early and mid 1970s, as well as the influence of U.S. tax laws on seed company owners near retirement age. She adds the important caveat, however, that while this may explain why seed companies were sold, it does not really explain why they were bought (p. 33).

Claffey also compared the change in U.S. seed prices from 1971 to 1980 with the change in machinery and fertilizer prices over the same period. She found that "the three industries demonstrated parallel and relatively comparable changes in sales growth and price increases. And there is no known evidence of collusion; rather changes in fundamental conditions perhaps explain the increases" (p. 34).

In examining the question of genetic variability, Claffey presents the views of those who are concerned about the impact of PVP on genetic vulnerability and those who are not (p. 35). Her main conclusions are that a comprehensive study is needed to examine the issues which PVP has raised (p. 36).

Responses from heads of 47 agricultural experiment stations to a brief survey conducted by Hanway (1978) revealed that 45 of the 47 would continue to release varieties (i.e., would not confine their activities to just basic research), while the 2 respondents who said they would not release varieties have terminated their crop breeding activities. In response to the question of whether the availability of PVP had reduced the level of plant breeding at their station, 45 of the respondents said that it had not, while 2 had no comment (p. 5).

Duvick (1981) sent questionnaires to the leaders of 125 breeding programs in the United States, both public and private, concerned with breeding cotton, soybeans, wheat, sorghum and maize, to determine whether PVP had affected genetic diversity in those crops. From the 101 responses which he received, Duvick provided the following summary:

> The proportion of U.S. crop land planted to small numbers of favorite cultivars of cotton, soybeans, wheat, sorghum and maize has decreased since 1970 but still is high. However, a large majority of U.S. plant breeding directors believe that these crops are not in serious danger from genetic vulnerability. They note that: cultivars are

> replaced every 7-9 years on average, providing genetic diversity in time; reserve cultivars number thousands per crop...; breeding pools are more diverse genetically than in 1970, due to planned introgressions of exotic germplasm... (p. 28)

THE UPOV EXPERIENCE

The International Union for the Protection of New Varieties of Plants (UPOV) is made up of states that are party to the International Convention for the Protection of New Varieties of Plants, which came into being in December 1961.[5] Since some members of UPOV have had PBR for almost two decades, it was felt that information about their experience would be of value to the present study. Consequently, a questionnaire (see Appendix) was sent to UPOV headquarters in Geneva, Switzerland, with a request that it be sent to the proper authorities in the various member countries. UPOV headquarters returned a summary or translation of the responses to this questionnaire. The countries which provided information include: Belgium, Denmark, France, the Federal Republic of Germany, New Zealand, South Africa, Sweden, Switzerland and the United Kingdom. Since the information obtained from the latter, by virtue of a separate survey of the British plant breeding community, is reported below, the U.K. responses will not be included here. Initially, the questionnaire did not include specific questions on the changes in seed prices since the introduction of PBR, or on the effect of PBR on genetic vulnerability. Therefore, a second questionnaire, covering these important concerns, was sent directly to the Plant Variety Offices of countries which had responded to the initial questionnaire. Responses were received from Belgium, France, the Federal Republic of Germany, New Zealand, Sweden and Switzerland.

All respondents felt that there had been an increase in the level of investment in plant breeding since the introduction of PBR in their countries. Only two indicated that they were not certain whether this increase was due to PBR.

Respondents were almost unanimous in their belief that there had been a shift in emphasis in public sector plant breeding away from varietal development. However, two responses were qualified by the belief that this shift to more basic research was due to the advent of private breeding as well as to the financial squeeze now facing governments. Only one respondent felt that there had been no such shift in his country.

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5. On January 1, 1982, the following countries were members of UPOV: Belgium, Denmark, France, the Federal Republic of Germany, Ireland, Israel, Italy, the Netherlands, New Zealand, South Africa, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Only one UPOV member felt that germ plasm exchange at the international level had been negatively affected since PBR, but indicated that this process had begun before PBR was introduced. All other respondents felt that PBR had not adversely affected germ plasm exchange and two even thought that germ plasm exchange had actually increased since the advent of PBR.

While all but one respondent indicated that there had been an increase in the number of new varieties available since PBR, most responses were qualified either by the statement that this increase was not necessarily due to PBR or by the observation that this increase was not uniform across all crops, but applied only to specific crops.

It was unanimously held that the quality of new varieties has improved since PBR was introduced. Respondents were also unanimous in stating that the collection of royalties on protected varieties had not posed any major problems.

A slight majority of those who responded felt there had been a change in the structure of the seed industry of their country either just prior to or after the introduction of PBR. However, none felt that this change could be specifically attributed to the introduction of PBR. The majority of respondents held the view that there had been no marked increase in the participation of multinationals in their respective seed industries. The majority among those who indicated that there had been an increase in multinational participation believed that this was entirely independent of PBR.

Almost all of those who responded indicated there had been no change in licensing requirements or equivalent since PBR. Only one respondent felt that there had been an increase in the strictness of testing for distinctness, uniformity and stability (DUS).

The majority of respondents did not know whether there had been a change in net royalty flows since PBR. Two felt that there had been a net outflow of royalties from their countries since PBR was introduced, while one felt the effect was mixed, depending on the type of crop being considered.

Respondents were unanimous in the belief that the overall effect of PBR on their countries was positive. The only negative effect reported by one respondent was the direct cost of operating the system. No suggestions were made for changing the present UPOV system of plant variety protection.

All but two respondents to the follow-up questionnaire indicated that seed prices had increased since the advent of PBR, but all attributed the increase to inflation rather than to PBR. One-half of those who replied felt that the relative increase in seed prices had been smaller than for other farm inputs, while the other half indicated they did not know how seed price increases compared with increases in other agricultural inputs.

All but one of the respondents were of the opinion that PBR did not increase the risk of genetic vulnerability. They stated categorically that while genetic vulnerability may be a concern, it was completely separate and distinct from PBR. The feelings of the final respondent regarding the relationship between PBR and genetic vulnerability were not clear.

THE U.K. EXPERIENCE

When the United Kingdom joined UPOV in 1964, the Plant Variety Rights Office (PVRO) was established to administer PBR. According to UPOV regulations, in order for a new variety to be granted protection, it must be shown to be distinct, uniform and stable (DUS) in official trials. When the United Kingdom entered the EEC in 1973, it was required to adopt the National List (NL) system, which also entailed tests for DUS, as well as the requirement that a new variety show value for cultivation and use (VCU).[6] The technical tests for DUS serve both PBR and NL purposes and it is for this reason perhaps that the two concepts are sometimes confused.

Information about the effects of PBR on the United Kingdom was obtained mainly from responses to a questionnaire which was mailed to 37 plant breeders and plant breeding organizations, both public and private, in that country.[7] The questionnaire dealt essentially with the claims and concerns which have been expressed about PBR. The United Kingdom was chosen for ease of communication and because it has had PBR since 1965 and is a member of UPOV.

In assessing the U.K. experience with PBR, it is clear that both public and private sector breeders are convinced that it has led to a greatly increased level of investment in plant breeding by the private

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6. Under EEC law, seed of agricultural and vegetable varieties may be marketed within the Community only if the variety concerned has been found to be DUS and has accordingly been entered on a National List of a member state. Agricultural crop varieties are also subject to an additional examination to establish satisfactory value for cultivation and use (i.e., has merit).

7. A copy of this questionnaire appears in the Appendix. Completed responses were received from 17 plant breeders and organizations, while 6 respondents indicated that they had forwarded the questionnaire to the British Association of Plant Breeders for completion. The remaining 144 questionnaires elicited neither a completed response nor acknowledgement of receipt.

sector, which would not have occurred otherwise.[8] There is, however, some question as to whether the entire increase in private plant breeding can be attributed to PBR.

There is some disagreement about the effect of PBR on public sector breeding programs. Some respondents indicated that they felt research expenditure in the public sector had increased, others, that it had decreased slightly, and still others felt it had stayed the same. The overall view, however, seemed to be that there had been little change in the support given to public sector breeding programs.

A small majority indicated that PBR had led to a slight shift in the emphasis of public sector breeding programs away from varietal development toward more basic research. Economic conditions are cited as being at least partly responsible for this shift.

There is almost complete agreement that PBR has not led to any new impediments to the exchange of information or breeding materials. A number of respondents cite an *increase* in germ plasm exchange since PBR was introduced into the United Kingdom.

Respondents indicated that there had been a tremendous increase in the number of new varieties available since PBR, both public and private.[9] The great majority were of the opinion that these new varieties, with only minor exceptions, displayed some improvements in terms of yield, grain quality, insect or disease resistance.

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8. Estimates and examples of the increase in private plant breeding include:

- an increase of 570 per cent in private investment between 1967 and 1979;

- an increase in full private sector membership in the British Association of Plant Breeders from 10 in 1967 to 23 in 1979;

- an increase in the number of new applications submitted for variety protection from 107 in 1966 to 157 in 1970, and 408 in 1978 and 276 in 1979.

9. The National Seed Development Organization Limited (NSDO) was set up in the United Kingdom, seemingly as a crown corporation, soon after the establishment of PBR to manage the multiplication, processing, sales and distribution of the seed of new public varieties in domestic and export markets. It now performs these functions for some private varieties as well. This organization appears to be operating well, and showed an after-tax retained profit of £209 thousand for 1981.

According to all respondents, the collection of royalties has not posed any problems in cereals. The U.K. Plant Royalty Bureau, which operates and polices the actual collection of royalties, is reported to run very smoothly and at very low cost (estimated to be between 1 and 2 per cent of gross royalty income). Some problems were mentioned in royalty collection on asexually reproduced varieties such as potatoes.

All respondents acknowledged that there had been a marked increase in multinational participation in the seed industry in the United Kingdom since PBR was introduced. Only a small minority, however, attributed this increased activity to PBR. Most indicated that economic conditions and the need for larger capital requirements to fund plant breeding were probably responsible for this change in seed industry structure. Almost no concern was evident that the presence of these multinationals was or would have a detrimental effect on the seed industry. Only one respondent cited the need to maintain a strong public sector input into plant breeding in order to ensure the continued health of the U.K. seed industry.

Licensing requirements for new varieties, according to most respondents, came into effect after PBR as a separate set of regulations providing user protection independently of PBR. Only one respondent felt that variety licensing was a necessary consequence of PBR.

There was no agreement on whether net royalty flows from protected varieties were having a positive or negative effect on the United Kingdom. Some respondents felt there was a net royalty outflow, others thought that the net flows were in balance, while still others felt that there was, or soon would be, a net inflow of royalty payments for protected varieties of U.K. origin.

It was the opinion of all respondents that the overall effects of PBR had been positive for the United Kingdom, with the single most important effect being the increase in private investment in plant breeding. The major negative effect mentioned by some was that the testing system was having difficulty coping with the dramatically increased number of new varieties. Although some stated that the costs of testing are high, it was not clear to what degree the testing system is self-supporting. Another criticism mentioned by a number of respondents was the inflexibility of the system's DUS requirements.

As with the UPOV countries, the first questionnaire sent to plant breeders and organizations in the United Kingdom failed to include specific questions on changes in seed prices since the introduction of PBR, or on the effect of PBR on genetic vulnerability. A second questionnaire covering these two important areas was sent to those who had either completed the previous questionnaire or had forwarded it to the British Association of Plant Breeders. Of the 23 questionnaires sent out (see Appendix for a copy), ten full responses were received.

There was unanimous agreement among the respondents that while seed prices had increased since the advent of PBR, the increase was due to a general price increase which could not be attributed to PBR. The majority believed that seed prices had increased relatively less than other farm inputs, while the remainder indicated that they did not know how the increase in seed prices compared to the change in the price of other farm inputs. Several respondents provided published farm input price indices which corroborated the view that, at least from 1975 to the present, seed price increases were relatively smaller than increases for other farm inputs.[10]

Respondents were unanimous in the view that the issue of genetic vulnerability was not related to PBR. Most indicated some concern about the apparent loss of genetic diversity worldwide in many important field crops. They felt, however, that the existence of PBR had no effect on this possible narrowing of the genetic base.

From the preceding discussion, it is clear that the respondents to our questionnaires believe that the introduction of PBR into the United Kingdom has had beneficial results, although more empirical work is required to determine the extent of the benefits. Similarly, the costs of the system need to be quantified for a conclusive judgement on the overall effects to be made.

THE U.S. EXPERIENCE

The U.S. Plant Variety Protection Act (PVPA) was passed in late 1970. The Plant Variety Office was set up to administer the provisions of the Act. Unlike the United Kingdom and other UPOV countries, the granting of PVP in the United States does not require independent trials by a national organization. Rather, the results of the breeder's own trials, in addition to a detailed written description of the new variety, are sufficient for rights to be granted if the new variety meets the DUS requirements.[11] Unlike the UPOV countries, which are also EEC members, the United States has no National List and no merit requirements which a new variety must display in order to be sold in commercial channels. Although it is true that national licensing requirements, or the equivalent, are not a requisite for PVP or PBR to operate, they do make

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10. The most recent information received indicated that in April 1982 the seed price index stood at 180.0 (1975 = 100), while the motor fuel index was 330.0, compound fertilizers stood at 189.3, straight fertilizer was 207.0, tractors stood at 248.7, while cultivation machinery and harvesting machinery were 226.9 and 263.8, respectively.

11. The detailed description provided by the breeder seeking protection is compared with the descriptions of other known existing varieties which are kept on file in a computer database.

a difference insofar as the potential proliferation of varieties which are only superficially differentiated in such matters as colour of bloom or shape of leaf.

Information about the impact of PVP on the U.S. seed industry was obtained through correspondence, as well as through interviews conducted with plant breeders, both public and private, and seed trade representatives in and around Fargo, North Dakota, and Minneapolis, Minnesota.

The United States was chosen for study because of ease of communication, because it has had PVP since 1970, and because it was felt that much of what occurred in the United States, especially in the north, would be transferable to Canada, in particular the prairie region.

There is unanimous agreement that there has been a dramatic increase in total private investment in plant breeding since the PVPA was passed. Despite this, the question of the effect which PBR itself has had on private plant breeding is not as straightforward and involves consideration of a number of diverse factors.

While everyone contacted felt that PVP was at least partly responsible for this increase, several indicated that other factors, such as the major grain deals between the United States and the Soviet Union in the early 1970s, may have been more important. Another point raised was that the increase in private plant breeding activity had not been uniform across crops. As reported in Batcha and Studebaker (1982), by far the largest increase has been in soybeans, with smaller, but still substantial increases having occurred in breeding wheat and cotton. It was suggested by many that increased interest in soybean breeding was due to the greatly increased acreage planted in that crop starting in the 1970s, as well as the fact that soybeans are a complementary crop to corn. A number of people felt there would have been sufficient motivation for an increase in private investment in breeding this particular crop even without PVP. As a rule, private breeding activity seems to be significantly and directly influenced by the planted acreage or market size of a particular crop. As such, there was no apparent increase in the private sector breeding effort in crops such as oats, and only a moderate increase in barley research. Wheat breeding effort was initially expanded but appears now to be diminishing.

A point which emerged in interviews was that there may have been overinvestment in plant breeding due to PVP. Cases were cited of small companies which apparently did not appreciate that there was a substantial time lag (12 to 15 years) between setting up a breeding program and successful development of new varieties. While many of these smaller firms have disappeared, it is estimated that there is still overinvestment in some areas, the 40 companies breeding soybeans in Minnesota being the most common example given.

Thus, while PVP is acknowledged as an important contributor to the growth of private sector plant breeding in some crops, the perception of long-term shortage in world food supplies is also considered an important explanatory factor. As well, PVP may have spawned over-investment in some crops, while having little or no effect on others.

According to the information collected, the level of public sector plant breeding appears to have remained unchanged or to have declined slightly since the advent of PVP. However, all those who felt it had declined indicated that this was probably due to economic belt tightening by government rather than PVP. All people contacted held firmly that there was a role for both private and public breeders. It was felt that the role of public breeders may change as a result of PVP, and there were differences of opinion as to whether such change is actually taking place and whether it should take place.

There is considerable disagreement about whether there has been a shift in emphasis in public sector breeding away from varietal development to more basic research. Despite Hanway's (1978) survey results (presented above), the majority of respondents felt that public sector research was being directed more toward basic research. A number of respondents stated that they had recently heard high-ranking U.S. Department of Agriculture officials indicate that this was indeed going to occur, and that apparently federal grants for applied plant breeding research have been declining. It was noted, however, that many state governments have replaced lost federal funds for crops important to their particular state. The federally funded competitive grants program for basic research is also considered to be one of the causes for the increase in basic research and another indicator of the federal position. However, there was little indication that such a shift was due to PVP.

While some respondents maintained that there had been no change in public sector policy regarding research objectives, more than one felt that there had actually been an increase in variety development by the public sector, at universities in particular, due to the fact that royalties could be collected on new varieties. A few expressed a concern for the future, that public breeders may be trapped into more varietal development work to the detriment of basic research. That is, if they make use of PVP to collect royalties on their new varieties, they may find that governments have cut their funding by an amount equal to the royalties collected. These public breeders would then be forced to continue to concentrate on variety development to maintain funding at a reasonable level.

There was complete agreement that the number of new private varieties available in some crops, notably soybeans, had increased substantially since PVP, while in others, such as oats, it had not. The majority felt that quality had been maintained in the new varieties, but a substantial minority felt that in a few cases quality had suffered.

There was agreement that in some crops, such as soybeans, there were perhaps too many new varieties, many of which were only superficially (i.e., phenotypically) different, making it difficult for farmers to choose among varieties and also overwhelming the capacity of state trials.

Under U.S. PVP there is no central agency for collecting royalties on protected varieties; royalties are collected on the basis of private agreements between buyer and seller. While there have been infringements of protection, the majority view is that this is not a serious problem. In part, this may be related to the fact that under PVP, the breeder has the option of allowing seed to be sold as Uncertified or Certified seed only. Apparently, breeders of protected varieties have almost unanimously required them to be sold only as Certified seed, so that violations can be prosecuted under state seed laws or through civil action under PVP. One concern expressed by some has to do not with royalty collection, but rather with charging royalties in the exclusive release of varieties to selected seed companies. The objection was not to the royalty per se, but rather to the unfair advantage given to these selected seed companies.

The public sector breeders in Fargo and Minneapolis were unanimous in their belief that royalties should not be charged on publicly developed varieties. This is because they felt it would, in effect, be asking the public to pay twice, since they had already paid for the breeding program which had produced the new variety. They were opposed to exclusive release with or without royalty collection unless this was the only way to ensure that varieties with a very limited market potential would find their way to their intended users. There are, however, some public institutions in the United States that do charge royalties on their new varieties, but we were unable to determine how prevalent this practice is.

There was general agreement that there has been a change in the structure of the U.S. seed industry since PVP. It was indicated by many that there has been a large increase in the number of small seed companies engaged in plant breeding, and at the same time there have been a large number of mergers or acquisitions of seed companies, including some of the larger seed companies (see Table 2, above).

There was almost total agreement that while PVP may have made the seed industry a slightly more attractive target for multinationals, it was economic conditions, including the relatively low value of the U.S. dollar and the perception of the seed industry as a future growth industry, which probably accounted for their interest. As well, the possibility of achieving economies of scale in marketing and promotion was mentioned by a substantial number as a reason for some acquisitions. It was also frequently pointed out that the experience of the seed companies during this period was not unique, with mergers and takeovers being the order of the day in many other industries as well. No information

is available on the concentration effects which these acquisitions have had, but it is generally believed that concentration is not a serious problem at this time.

An interesting point made by John A. Studebaker (1982) is that "the list of successful multinationals that have *sold* seed companies is practically as long as [the list of] those purchasing [seed companies]..." (p. 10). However, despite this, there still appears to be considerable concern about the potential for domination of the seed industry by multinationals, especially if there is a diminution or suspension of public sector variety releases.

Despite the fact that the PVPA allows free use of protected varieties as germ plasm for varietal development, a large majority of respondents felt that there had been a decrease (or at least a slowdown), directly attributable to PVP, in the exchange of information and breeding materials between public breeders and between public and private breeders. The decrease in varieties put into regional nurseries was often cited as evidence of this decline. Within this majority view, there were some who believed that this situation was only a temporary phenomenon. Even those who expressed a great concern about germ plasm exchange indicated that they felt things were not as bad as they had thought they might be. A small minority felt that there had been no change in the rate of germ plasm exchange since PVP, while several believed that exchange had increased, at least in a global context.

It was generally estimated that the fees charged by the Plant Variety Office to protect varieties covered approximately one third of the actual cost. Many expressed the belief that fees would soon be raised to cover a much larger proportion, if not the entire cost incurred by the Plant Variety Office. A small number expressed concern about about the growth of the Plant Variety Office since 1970, with some estimating that it had tripled in size since it commenced operation.

There was general agreement that seed prices had increased since the advent of PVP, as Claffey's 1981 study indicated, and most agreed that at least part of the increase was due to PVP. It was acknowledged by most that seed prices had increased less than most other farm inputs. There was, however, some disagreement about whether or not the increase in seed prices was justified by associated increases in yield. It was estimated by some that public varieties of equal quality to private varieties were selling at about two-thirds the price of the latter. It was also pointed out that in some cases, private varieties were selling for double the price of equivalent public varieties. Intense advertising and promotion of private varieties were the reasons most often cited for these higher prices.

Although genetic vulnerability was recognized as a problem by almost all respondents, the majority agreed with Ruttan (1982), who writes:

> It is now generally accepted by those concerned with conservation of genetic materials that it is the increased availability of higher yielding crops rather than varietal protection itself that is the major threat to the continued existence of varietal diversity in the historic centers of origin of crop species. The appropriate response to this concern is more adequate support for crop exploration; for seed storage and preservation; and for associated taxonomic and cytogenetic research. (pp. 8-19)

The majority of those contacted indicated that the overall effects of PVP for the United States have been positive. Although many felt that PVP had provided substantial net benefits, an equal number felt that the net benefits of the system were marginal. Many expressed the view that PVP had not lived up to expectations. It should be noted, however, that since PVP has been in existence for just over a decade, the fruits of any increased plant breeding effort which it inspired may be just starting to be realized. Therefore, the benefits of the system may become more evident as time goes by.

In considering the negative effects of PVP, the majority of concerns expressed relate more to the future than to the present. These concerns centred on germ plasm exchange and the future of public plant breeding, with special concern about the impact on variety improvements and seed prices if a strong public presence is not maintained.

Another area of concern was that the private sector is not capable of providing the United States with a continuous flow of improved varieties without continued public sector input. The example of what has happened in hybrid corn was often cited: although private companies are responsible for about 85 per cent of the breeding effort and 80 per cent of the varieties used in commercial production, 50 per cent of the inbred lines used in hybrid corn production in the United States were developed by *public* sector breeders (ibid., pp. 8-20; Hanway 1978, p. 5).

Finally, but perhaps most pertinent to this study, were the responses to the last questions, one of which dealt with retention or abolition of PVP, the other with the potential for increased private breeding in Canada if PBR were introduced.[12] A large majority of those in the *public sector*, who were asked whether they would retain PVP legislation or abolish it if they had the choice, *said that since the system was in place, they would retain it, but if it were not yet in place they would have grave reservations about setting it up. Those in the private sector were unanimous in the view that they would retain it.* However, the impression that we were left with from both the public

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12. These questions were asked *only* of those people interviewed in Fargo and Minneapolis (see Appendix). They were *not* asked of people contacted by letter or telephone.

and private sector people was that the overall impacts on the United States of PVP have not been particularly strong, either positively or negatively.

When asked whether the passing of PBR legislation in Canada would influence the decision of private firms to invest in plant breeding research in Canada, both private and public sector people responded that there were more important considerations, such as the licensing system that exists in Canada and the small size of the Canadian market, which would most likely override any positive stimulus of PBR. While interest was expressed in testing new varieties which were developed in the United States for licensing in Canada, there was little enthusiasm for setting up breeding programs in, or specifically for, Canada.

PROSPECTS FOR CANADA

In order to learn what members of the Canadian seed industry thought about PBR, we contacted plant breeders, both public and private, as well as seedsmen. While we were interested in their opinions about the potential effects of PBR on Canada, we were more interested in learning about any negative effects on the Canadian seed industry that were due to this country's lack of PBR legislation.

Like many of their counterparts in UPOV member countries, many seed industry members in Canada believed that PBR would lead to increased private expenditure on plant breeding for certain crops. Despite federal government assurances to the contrary, a good deal of concern was expressed in both the public and private sector about the possibility of reduced government support for public plant breeding in the future, especially for variety development. Also, although the federal government is on record as being committed to maintaining current variety licensing requirements, quite a number of people expressed the view that if private investment in plant breeding increased, there would be irresistible pressure brought to bear to modify the licensing system.

Little concern was expressed about the acquisition of Canadian seed companies by multinationals. It was felt that the market share which these seed companies represented was very small and did not pose a threat to the competitive structure of the industry.

There was unanimous agreement among plant breeders that there had been no change in the rate of germ plasm exchange with breeders in countries which had adopted PBR. Similarly, there was almost complete agreement among seedsmen that Canadian growers were not being deprived of the best varieties because of a lack of PBR. This is partly due to the fact that very few European varieties are suited for Canadian growing conditions. As well, the Canadian licensing system does not permit some European and U.S. varieties that are adapted to conditions here to be grown in Canada. Seedsmen have indicated that some foreign varieties are licensed and made available under exclusive agreements with Canadian seed companies.

There is some confusion as to why Agriculture Canada has touted PBR as an avenue for royalty collection on publicly released varieties to help support public breeding effort, but has chosen not to collect royalties on varieties released through SeCan. This is a point that bears further investigation.

The people contacted did not indicate any significant negative effects attributable to the fact that Canada does not have PBR legislation: even those who favoured its introduction communicated no sense of urgency. At the same time, there does not seem to be any great opposition to the introduction of PBR provided there is a guarantee of continued government support for public plant breeding. The feeling exists, however, that the present varieties licensing system, combined with the SeCan Association, could fulfil all the domestic requirements of PBR. That is, royalties can be collected by SeCan on new varieties if the breeder or breeding organization so chooses. The licensing system ensures that new varieties are visually distinguishable from existing ones as well as meeting all existing quality standards and exceeding at least one of them. In this latter regard, the Canadian licensing system imposes a more stringent requirement than the UPOV system where new varieties need only be DUS. Many felt that if international arrangements for reciprocity in the release of new varieties could be established through SeCan, then passing Bill C-32 and setting up a legislated PBR organization would be redundant. Even if this could not be achieved, it was felt that because of the seemingly limited potential exchange of varieties between Canada and other countries, the current system of individual agreements between foreign seed companies and their Canadian counterparts would allow Canadian farmers access to the best foreign varieties.

APPENDIX

Questions sent to UPOV members:

1. Has PBR led to a change in the level of investment in plant breeding by either the private or public sector which would not otherwise have taken place?

2. Has there been a shift in the emphasis of plant breeding effort in the public sector away from varietal development to more "basic" research?

3. Has the exchange of germ plasm between plant breeders at the national or international level been affected by PBR?

4. a) Has there been a marked change in the number of new varieties of grains and oilseeds which have been introduced annually for commercialization since PBR was introduced?

   b) Has there been a change in the quality of new varieties which have been introduced?

5. Has the collection of royalties on protected varieties posed any major problems?

6. a) Has there been a discernible change in the structure of the seed industries in UPOV member countries since UPOV was established?

   b) In particular, has there been a marked change in the participation of multinational enterprises in the seed industries?

7. Has there been a change in licensing requirements, or equivalent, for new varieties since PBR was introduced?

8. Has there been a change in net royalty flows into or out of UPOV member countries since PBR came into effect?

9. a) Do you feel that the overall effects of PBR have been positive for UPOV members?

   b) What do you consider to be the most important negative effects, if any, which PBR has had on the seed industries of members of UPOV?

   c) What changes, if any, should be made to the present UPOV convention to improve the current situation?

Questions sent to members of the U.K. seed industry:

1. Has PBR led to a change in the level of investment in plant breeding by either the private or public sector which would not otherwise have taken place?

2. Has there been a shift in the emphasis of plant breeding effort in the public sector away from varietal development to more "basic" research?

3. Has the exchange of germ plasm between plant breeders at the national or international level been affected by PBR?

4. a) Has there been a marked change in the number of new varieties of grains and oilseeds which have been introduced annually for commercialization since PBR was introduced?

   b) Has there been a change in the quality of new varieties which have been introduced?

5. Has the collection of royalties on protected varieties posed any major problems?

6. a) Has there been a discernible change in the structure of the seed industry in the U.K. since PBR legislation was passed?

   b) In particular, has there been a marked change in the participation of multinational enterprises in the seed industry?

7. Has there been a change in licensing requirements, or equivalent, for new varieties under the Seeds Act since PBR was introduced?

8. Has there been a change in net royalty flows into or out of the U.K. since PBR came into effect?

9. a) Do you feel that the overall effects of PBR have been positive for the U.K.?

   b) What do you consider to be the most important negative effects, if any, which PBR has had on the seed industry in the U.K.?

   c) What changes, if any, should be made to the present UPOV convention to improve the current situation?

Questions asked of various U.S. seed industry members, either over the telephone or through the mail:

1. Has PVP led to a change in the level of investment in plant breeding by either the private or public sector which would not otherwise have taken place?

2. Has there been a shift in the emphasis of plant breeding effort in the public sector away from varietal development to more "basic" research? Is this good or bad?

3. Has the exchange of germ plasm between plant breeders at the national or international level been affected by PVP?

4. a) Has there been a marked change in the number of new varieties of grains and oilseeds which have been introduced annually for commercialization since PBR was introduced?

   b) Has there been a change in the quality of new varieties which have been introduced?

5. Has the collection of royalties on protected varieties posed any major problems?

6. a) Has there been a discernible change in the structure of the seed industry in the United States since PVP?

   b) In particular, has there been a marked change in the participation of multinational enterprises in the seed industry?

7. a) What has happened to the costs of the system?

   b) What has happened to seed prices?

8. a) Do you feel that the overall effects of PBR have been positive for the United States?

   b) What do you consider to be the most important negative effects, if any, which PVP has had on the seed industry in the United States?

   c) What changes, if any, should be made to the present legislation to improve the current situation?

Follow-up questions sent to UPOV members, and U.K. and U.S. seed industry members:

1. a) Has there been a significant change in seed prices since the introduction of PBR?

   b) If so, how does this compare with changes in other major farm inputs such as fuel, fertilizer and herbicides/pesticides?

   c) Increased risk of "genetic wipeout" or genetic vulnerability has been cited as a negative impact of PBR. Do you feel that such a view is justified?

BIBLIOGRAPHY

Agricultural Institute of Canada. 1979. Plant breeders' rights. Ottawa: Agricultural Institute of Canada. Mimeo.

Albach, Horst. 1979. Market organization and pricing behavior of oligopolistic firms in the ethical drugs industry. *Kyklos* 32: 523-40.

Australia. 1981. Department of Primary Industry. Plant variety rights: Information paper. Canberra. Mimeo.

Banks, M.A.L. 1970. *The British patent system.* Report of the committee to examine the patent system and patent law. London: The Queen's Printer.

Barry, S.C. 1977. Plant breeders' rights -- and the Canadian Seed Growers' Association. In Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 91-92. Mimeo.

Batcha, John A., and John A. Studebaker. 1982. *A chronicle of plant variety protection.* Kalamazoo, Mich.: Asgrow Seed Co.

Beck, Roger L. 1976. Patents, property rights, and social welfare: Search for a restricted optimum. *Southern Economic Journal* 43(2): 1045-55 (October).

_____. 1978. Patents and over-investment in process inventions: Reply. *Southern Economic Journal* 45(1): 289-92 (July).

_____. 1980. Competition for patent monopolies. Paper presented at the 54th Annual Western Economic Association Conference, 18 June, in San Diego, Calif. Mimeo.

_____. 1981. Should the patent system be changed? Faculty of Business Administration and Commerce, Univeristy of Alberta, Edmonton. Mimeo.

Beeler, Byron. 1977. Does the Canadian seed trade want breeders' rights and why? In Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 77-79. Mimeo.

Billings, James R. 1981. Public vs. private research in plant breeding. Presentation to the 27th Farm Seed Conference, 10 November, in Kansas City, Mo. Mimeo.

Bradnock, W.T. 1977. A comparison of the United States and European systems of plant breeders' rights and possible choices for Canada. In Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 71-74. Mimeo.

Canada. Consumer and Corporate Affairs Canada (CCAC). 1976. *Working paper on patent law revision*. Ottawa: Minister of Supply and Services.

_____. Consumer and Corporate Affairs Canada (CCAC). 1977. *Patents: An introduction*. Ottawa: Minister of Supply and Services.

_____. Department of Industry, Trade and Commerce. 1979. *The health care products industry: Research and development in Canada, a background paper*. Ottawa: Minister of Supply and Services.

_____. Economic Council of Canada (ECC). 1971. *Report on intellectual and industrial property*. Ottawa: Information Canada.

_____. Foreign Investment Review Agency. 1974/75 - 1982/83. *Foreign Investment Review Act*, annual reports. Ottawa: Minister of Supply and Services.

_____. *Patent Act*. R.S.C. 1970, c. P-4.

_____. *Plant Breeders' Rights Act*, Bill C-32. 1980, 32d Parl., 1st Sess.

_____. Royal Commission on Corporate Concentration (RCCC) 1976. *Report of the Royal Commission on Corporate Concentration*. Ottawa: Minister of Supply and Services.

_____. Seeds Act. R.S.C. 1970, c. S-7.

_____. Statistics Canada. 1978. *Industrial organization in the manufacturing, mining and logging industries, 1974*. Cat. no. 31-402. Ottawa: Minister of Supply and Services.

Canadian Seed Growers' Association. 1980. *Regulations and procedures for pedigreed seed crop production*. Ottawa: Canadian Seed Growers' Association, circular no. 6-80.

Claffey, Barbara A. 1981. Patenting life forms: Issues surrounding the Plant Variety Protection Act. *Southern Journal of Agricultural Economics* 13(2): 29-37.

Comanor. W.S. 1967. Market structure, product differentiation, and industrial research. *Quarterly Journal of Economics* 81(4): 639-57 (November).

Cook, Jack. 1982. Northern seeds for northern gardens. *Horticulture* (March): 22-28.

Downey, R.K. 1977. Plant breeders' rights -- Viewpoint of a plant breeder in the public sector. Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 88-90.

Duvick, Donald N. 1981. Genetic diversity in major farm crops on the farm and in reserve. Paper presented to the 13th International Congress of Botany, August, in Sydney, Australia. Mimeo.

Dyck, Peter. 1977. Introductory remarks. Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 69-74.

Ellis, E.D. n.d. An application of the dominant firm model to the Canadian diazepam market. Consumer and Corporate Affairs Canada, Ottawa. Mimeo.

_____. n.d. Costs and benefits of plant breeders' rights in Canada. Ottawa: Consumer and Corporate Affairs Canada. Mimeo.

Firestone, O.J. 1971. *Economic implications of patents*. Ottawa: University of Ottawa Press.

_____. 1973. American patent utilization in Canada. *Canadian Patent Reporter* 10(2): 110-119 (May).

Franko, Lawrence S. 1976. *The European multinationals*. Stanford, Conn.: Greylock Publishers.

Galbraith, J.K. 1952. *American capitalism*. Boston: Houghton Mifflin.

Gamble, Edwin E. 1977. The universities and breeders' rights. Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man., 75-76.

Globerman, S. 1973. Market structure and R & D in Canadian manufacturing industries. *Quarterly Review of Economics and Business* 13(2): 59-67 (Summer).

Godden, David. n.d. Plant variety rights: An annotated bibliography. New South Wales Department of Agriculture, New South Wales, Australia, miscellaneous bulletin. Mimeo.

_____. 1980. Plant variety rights: Some economic issues. Revised version of a talk given to a combined meeting of the New South Wales Branches of the Australian Agricultural Economics Society and the Australian Institute of Agricultural Science, 10 June, in Sydney, Australia. Mimeo.

Godden, David, and Roy Powell. 1981. Economic aspects of plant variety rights: Models for examining their effects. Paper presented to the Australia-New Zealand Annual Agricultural Symposium (ANZAAS), Australia. Mimeo.

Gordon, Myron, and David Fowler. 1980. *The drug industry: A case study in foreign control*. Toronto: James Lorimer and Co.

Gorecki, Paul K. 1981. *Regulating the price of prescription drugs in Canada: Compulsory licensing, product selection, and government reimbursement programs*. Ottawa: Economic Council of Canada, Technical report no. 8.

Gorecki, Paul K., and Ida Henderson. 1981. Compulsory patent licensing of drugs in Canada: A comment on the debate. *Canadian Public Policy* 7(4): 559-68 (Autumn).

Grabowski, H.G. 1968. The determinants of industrial research and development: A study of the chemical, drug and petroleum industries. *Journal of Political Economy* 76(2): 292-306 (March-April).

Grabowski, H.G., and N.D. Baxter. 1973. Rivalry in industrial research and development. *Journal of Industrial Economics* 21(2): 209-35 (July).

Grabowski, H.G., J.M. Vernon, and L.G. Thomas. 1978. Estimating the effects of regulation on innovation: An international comparative analysis of the pharmaceutical industry. *Journal of Law and Economics* 21(1): 133-64 (April).

Grasley, R.H., and J.D. Dermer. 1979. *The status of innovation in the strategies of larger Canadian corporations*. Ottawa: Industry, Trade and Commerce, Technological Innovation Studies Program, research report no. 61.

Hamberg, D. 1966. *R & D: Essays on the economics of research and development*. New York: Random House.

Hanson, A.A. 1980. The interaction of public and private plant breeders in development and release of germplasm. In Twenty-Sixth Grass Breeders' Work Planning Conference, 18-20 June, at Utah State University, Logan, Utah, 69-74.

Hanway, D.G. 1978. Agricultural experiment stations and the plant variety protection act. *Crops and Soils* 30(5): 5-6 (February).

Henry, D.J. 1976. Multi-national practice in determining provisions in compulsory patent licences. *Journal of International Law and Economics* 2(2): 325-51.

Hodgson, H.J. 1971. Scope and character of public plant breeding research in the U.S. *Agriculture Science Review* 9(4): 36-43.

Horowitz, I. 1962. Firm size and research activity. *Southern Economic Journal* 28(1): 298-301 (January).

International Association of Plant Breeders (ASSINSEL). n.d. *Feeding the 5000 million*. Amsterdam: ASSINSEL.

International Cooperation. 1980. The arguments for a white paper on plant breeders' rights. Ottawa: International Cooperation. Mimeo.

International Union for the Protection of New Varieties of Plants (UPOV). 1982. *General information*. Geneva, Switzerland: Office of UPOV, publication no. 408.

Kalton, R.R. 1981. Public vs. private research in plant breeding. Paper presented at the 27th Farm Seed Conference, 10 November, in Kansas City, Mo. Mimeo.

Kamien, M.I., and N.L. Schwartz. 1975. Market structure and innovation: A survey. *Journal of Economic Literature* 12(1): 1-37 (March).

Kitch, E.W. 1977. The nature and function of the patent system. *Journal of Law and Economics* 20(1): 265-80.

_____. 1980. Patents, prospects, and economic surplus: A reply. *Journal of Law and Economics* 23(1): 205-7 (April).

Landau, D.L. 1978. Patents and overinvestment in process inventions? Comment. *Southern Economic Journal* 45(1): 285-88 (July).

LeNeveu, A.E. 1981. The pharmaceutical industry: An overview. In *Pharmaceuticals in North America: The public interest*. Proceedings of the 22d Annual Meeting of the Institute for Canadian-American Studies, 13-14 November 1980, at the University of Windsor. Windsor, Ont.: Institute for Canadian-American Studies.

Liebenluft, Robert F. 1981. *Competition in farm inputs: An examination of four industries*. Washington, D.C.: Federal Trade Commission, Office of Policy Planning.

Lustgarten, S. 1979. Gains and losses from concentration: A comment. *Journal of Law and Economics* 22(2): 183-90.

Macartney, L. 1978. The multinational connection: Who produces Canada's agricultural inputs? *Agrologist* 71(1): 15-18 (Winter).

McFetridge, D.G., and D.A. Smith. 1980. Patents, prospects, and economic surplus: A comment. *Journal of Law and Economics* 23(1): 197-203 (April).

McGee, John S. 1966. Patent exploitation: Some economic and legal problems. *Journal of Law and Economics* 9: 135.

Machlup, E. 1958. *An economic review of the patent system.* Prepared for the U.S. Senate Subcommittee on Patents, Trademarks and Copyrights. 85th Cong., 2d Sess, study no. 15. Washington, D.C.: Government Printing Office.

Mandeville, T.D., and D.M. Lamberton. 1981. Impact of government regulation: The case of patents. Paper presented at the Institute of Industrial Economics Conference on Government Regulation of Industry, 19-20 February, at the University of Newcastle. Mimeo.

Mansfield, E. 1960. *Industrial research and technological innovation: An econometric analysis.* New York: Norton for the Cowles Foundation for Research in Economics at Yale University.

Markham, J.W. 1965. Market structure, business conduct and innovation. *American Economic Review* 55(2): 323-32. Part II Supplement (May).

Murchison, D.F. 1978. Patents and the innovative process. Mimeo.

Murphy, P.W. 1981. Plant breeders' rights and the improvement of plant varieties. *UPOV Newsletter* (Geneva), no. 25: 24-30 (February).

_____. 1979. Plant breeders' rights in the United Kingdom. *EIPR* (September): 236-40.

National Seed Development Organization Ltd. 1981. *Fourteenth annual report and accounts, 1980-81.* London: National Seed Development Organization Ltd.

North Dakota State Seed Department. 1980. *North Dakota seed certification standards.* Fargo, N.D.: North Dakota State Seed Department, bulletin no. 51.

Organization for Economic Co-operation and Development (OECD). 1977. *Impact of multinational enterprises on national scientific and technical capacities, pharmaceutical industry.* Paris: OECD.

Palda, Kristian S., and Bohumir Pazderka. 1980. *Background to a target: An international comparison of the Canadian pharmaceutical industry's R & D intensity.* Ottawa: Industry, Trade and Commerce, Technological Innovations Studies Program, research report no. 71.

Pardee, W. 1981. Public vs. private plant breeding: A view from the public side. Panel discussion at the 27th Farm Seed Conference, 10 November at Kansas City, Mo. Mimeo.

Pletzman, S. 1977. The gains and losses from concentration. *Journal of Law and Economics* (20(3): 229-61 (October).

Peltzman, S. 1979. The causes and consequences of rising industrial concentration: A reply. *Journal of Law and Economics* 22(2): 209-11.

Phlips, L. 1971. *Effects of industrial concentration: A cross section analysis for the common market.* Amsterdam: North-Holland Publishing Co.

Priest, George L. 1977. Cartels and patent licence arrangements. *Journal of Law and Economics* 20(3): 309-77 (October).

Proceedings of the conference on plant breeding and breeders' rights in Canada. 1971. 15-16 June, at the University of Guelph.

Reekie, D.W. 1978. Price and quality competition in the United States drug industry. *Journal of Industrial Economics* 26(3): 223-38 (March).

Robinson, C. 1972. Patent protection for chemical products in Canada, Great Britain and the United States. *IIC* 3(2): 139-51.

Rugman, Alan M. 1981. Research and development by multinational and domestic firms in Canada. *Canadian Public Policy* 7(4): 604-16 (Autumn).

Ruttan, V.W. 1982. *Agricultural research policy.* Minneapolis: University of Minnesota Press.

Samuelson, Paul A., and Anthony Scott. 1975. *Economics,* 4th Can. ed. Toronto: McGraw-Hill Ryerson Ltd.

Scherer, F.M. 1965a. Firm size, market structure, opportunity and the output of patented inventions. *American Economic Review* 55(5): 1097-1125 (December).

_____. 1965b. Size of firm, oligopoly and research: A comment. *Canadian Journal of Economics and Political Science* 31(2): 256-66 (May).

_____. 1967. Market structure and the development of scientists and engineers. *American Economic Review* 57(3): 524-31 (June).

_____. 1977. *Economic effects of compulsory patent licensing.* New York: New York University.

_____. 1979. The causes and consequences of rising industrial concentration. *Journal of Law and Economics* 22(2): 191-208.

_____. 1980. *Industrial market structure and economic performance,* 2d ed. Chicago: Rand McNally.

Schumpeter, J.A. 1950. *Capitalism, socialism and democracy*. New York: Harper and Row.

Schwartzman, David. 1977. *Innovation in the pharmaceutical industry*. New York: Johns Hopkins.

SeCan Association. 1981. *SeCan Association: 1981 Annual Report*. Ottawa: SeCan Association.

Silvey, V. 1980. The influence of improved crop varieties and husbandry methods on increasing cereal yield. *Phoenix*. (Bulletin of the Agriculture Development and Advisory Service), no. 102: 1-5 (June).

Studebaker, J.A. 1982. Fifty years with breeders' rights and plant variety protection. Paper presented to the California Seed Trade Association, 17 March, in Las Vegas, Nev. Mimeo.

Taylor, C.T., and Z.A. Silbertson. 1973. *The economic impact of the patent system*. Cambridge: University of Cambridge Press.

U.S. Congress. 1979. House Committee on Agriculture. *Select Senate Hearings of the Subcommittee on Department Investigations, Oversight and Research of the House Committee on Agriculture on H.R. 999, held 19 July 1979*. Washington, D.C.: U.S. Government Printing Office.

U.S. President's Commission on the Patent System. 1966. *To promote the progress of the useful acts is an age of exploding technology*. Report of the President's Commission on the Patent System. Washington, D.C.: U.S. Government Printing Office.

Whelan, E. 1977. The government view on breeders' rights. Proceedings of the Eighth Annual Meeting of the Canada Grains Council, 5-6 April, in Winnipeg, Man. 62-65.

White, L.R. n.d. Extract from talk by L.R. White, President, to joint meeting of Western seed growers and seed trade, 30 October, in Winnipeg. Ottawa: SeCan Association. Mimeo.

Williamson, O.E. 1965. Innovation and market structure. *Journal of Political Economy* 73(1): 67-73 (February).

Worley, J.G. 1961. Industrial research and the new competition. *Journal of Political Economy* 69(2): 183-86 (April).