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PART THREE:
Intellectual Property Rights

18. Strategy and Incentives in the Compulsory Licensing of Intellectual Property in Agriculture

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Chapter 18

Strategy and Incentives in the Compulsory Licensing of Intellectual Property in Agriculture

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Introduction

There are a number of economic forces at work that are helping to focus public interest on the actual and potential roles to be played in the agriculture and biotechnology sectors by numerous forms of intellectual property rights (IPRs). Compulsory licensing is one instrument of intellectual property policy whose role, historically, has not been widely understood or well defined. The larger public debate about the optimal promotion and regulation of biotechnology in agriculture (see, for example, Canada 1998a, 1998b) provides a timely opportunity to examine the specific economic incentives that can be provided by compulsory licensing provisions, and to identify how their actual contribution and effectiveness can be increased.

A compulsory license is a property right provided to one or more agents by the licensing or patent authorities that allows the holder of the compulsory license to use, to infringe or to exploit the rights previously granted to someone else. Thus, a compulsory license is a specific form of relaxation of, or exemption to, a right previously granted. A compulsory license may be granted subject to any number of terms, such as those that specify royalties or license fees that must be paid to the holder of the original rights or terms that confer a reciprocal right or privilege on the original rights holder.

Recent research on intellectual property policy has examined, for example, incentive effects on cumulative research, where, over time, the patented or licensed result of one firm's research and development (R&D) endeavors becomes the building block for another firm's activity. The result of such a process often includes a second patentable innovation, which may or may not infringe the first patent. When it does infringe, the second patent may not be worked by either firm without the agreement of both. A voluntary licensing agreement between the parties is a common way to resolve this potential conflict, yet sometimes the parties might be unable to reach terms that are in each's interests. Here, a compulsory license (on the first patent) would be a form of imposed agreement for the second firm to work both patents.

This chapter will focus on the potential role and importance of provisions for compulsory licensing within a system of intellectual property rights in sustaining innovation and technological change in agriculture; a sector where the R&D process is typically cumulative. The potential role of compulsory licensing of other IPRs will be illustrated by reference to the

strategic incentives such licenses may provide in a non-cooperative game and by reference to other economic research analyzing alternate designs for such a system. The actual role of compulsory licensing will be illustrated by reference to Canada's system of Plant Breeders' Rights (Canada 1990, 1991).

The next section of this chapter describes more generally the public policy problem in regulating or licensing agricultural research. The third section describes the potential role to be played by compulsory licensing which is then illustrated by reference to a theoretical model of firm behavior in the presence of compulsory licenses. There is a brief review of policy design issues for compulsory licensing. The final sections of the chapter present the actual Canadian experience and discuss related international developments.

The Public Interest in the Creation of Compulsory Licenses

An economist's rationalization for having any public policy or regulatory role governing private research, be it in agriculture or elsewhere, is that a market economy, especially one with an R&D system based largely on private innovators, may supply an amount of R&D activity which is below that society would view as optimal. This stems from the claim that successful R&D is often capable of providing (social welfare) gains to society in excess of the private profits which will be earned by the (private) innovator who undertakes it. Although this market failure defines a *potential* role for policy, public involvement may still only be warranted where it can improve on this situation, such as through encouraging additional R&D which yields social benefits in excess of social costs.[2]

Where governments are to play a role in defining (or re-defining) the incentives and constraints faced by innovators, government decisions need to be informed by concerns of economic efficiency (in both a static and dynamic sense) and economic equity. Typically, the many parties affected by such policy decisions in the agricultural sector will include producers, consumers, taxpayers, and researchers in the private and public sectors. Rarely will all of these parties' interests converge. Whereas efficiency and equity concerns each have a place on the policy agenda, the most intense interest in the economics literature seems to focus on efficiency questions, ranging from concerns about the ability of specific countries to support internationally-competitive, yet domestically-responsive, R&D sectors, to encouraging an industry structure that limits the undue or undesirable exercise of market power. For many countries, an important issue is how R&D costs and future rents are to be shared, such as when a policy results in reallocation among researchers, producers and consumers, or between domestic interests and foreign. Nonetheless, the following discussion will focus primarily on the magnitude of potential gains, not on their distribution.

For concerns about under-supply of agricultural R&D per se, the design and use of appropriate intellectual property rights, such as a system that features compulsory licensing, constitutes only one instrument in the public policy arsenal. That is, although most trading

nations will be expected to have some form of IPR regime in place, these IPR initiatives need not be the central focus of public action. Other well known policy approaches which are often available include: (i) promoting all forms of technology transfer among countries; (ii) provision of (some or all) R&D in public facilities at public expense; (iii) public funding of R&D undertaken in private institutions; and (iv) promoting trade in goods and services as a means of specializing toward sectors where a country has a comparative advantage due to technology.

Importantly, the available policy alternatives to address low levels of R&D are not mutually exclusive; indeed, they may be complemented by improved policies with respect to IPRs. For example, countries which allow private and public researchers to earn royalties from the technologies those researchers develop might experience increases in such inventive activity.[3] Countries which fail to recognize or to enforce the IPRs of other potential trading partners may discover that those partners are reluctant to trade in certain goods or services, for fear that the technology imbedded in them may be appropriated without compensation, and in the worst case, re-exported to third countries. Thus, even in the presence of alternative policies, a country might benefit from defining carefully the precise role of IPRs in the development of its domestic capacity to undertake, and to benefit from, agricultural R&D.

The Potential Role of Compulsory Licenses

To appreciate the specific role that compulsory licensing could play within a country's IPR regime, it is instructive to consider how such licenses have been used and could be used in relation to patents and other IPRs. Nordhaus (1969) characterizes a patent as conferring a monopoly to its holder over some future period of time (the *life* of the patent). The patent-holder is intended to earn above-average profits (economic rents) either as a monopoly producer or through voluntarily licensing this monopoly power to others for a fee. The prospect of earning such profits serves as an incentive to innovate ex ante, and the disclosure requirements faced by applicants facilitate diffusion of the patented knowledge. The introduction of IPRs may influence not only the price and quantity of patented goods sold, but also the market structure of the industry, and the rate—and ultimate "success"—of the research effort.

The focus of the Nordhaus (1969) analysis is on comparing the present value of gains (to producers and consumers) resulting from marketed inventions with the present value of losses (to consumers) from bestowing monopoly powers upon the patent-holder for some duration of time. Thus, although patents and other IPRs are intended to provide economic incentives for firms to perform innovative activity, the (potential) social benefits are accompanied by social costs.

A large literature has developed showing how the relative costs and benefits of IPRs will vary according to the characteristics of:

i. the particular type of proprietary right being granted (e.g., cost of acquisition, duration, jurisdiction, provision for compulsory licensing, degree of enforceable and effective protection against imitation);
ii. the research process itself (e.g., structure of the industry conducting the research, extent of information sharing among participants, the influence of returns-to-scale or learning-by-doing on the rate of innovation); and
iii. the products being produced under IPR protection (e.g., price elasticity of demand, expected rate of adoption and the expected product life of a specific invention, the role of advertising in influencing product adoption decisions, and the value of "small" versus "large" product changes relative to research costs).

Various authors have suggested how specific design characteristics of the IPRs, such as length of life (Nordhaus 1969, Cornelli and Schankerman 1999), breadth of protection[4] (Green and Scotchmer 1989; Klemperer 1990, O'Donoghue *et al* 1998), and enforcement provisions (Scotchmer and Green 1990; Waterson 1990), can be used to maximize the difference between these benefits and costs. A compulsory licensing provision is one such design characteristic and one whose effects will be explored in detail below. That is, a patent or other IPR might include a requirement for compulsory licensing of the protected material from the holder to other firms, often in exchange for payment of a prescribed fee or royalty. Where patents are the IPR of choice, there tends to be a patent life which is common to all products, with a common provision for licensing, a common breadth of protection, and so on. A potential strength of compulsory licensing is that it could be applied on a case-by-case basis where some other IPR measures could not.

Compulsory licensing has received relatively infrequent use in jurisdictions such as the United States (see Scherer 1977; Tandon 1982; and Kaufer 1989). When it has been used in the U.S., its role has often been related to anti-trust policy, where the purpose of the licensing requirement is to reduce the undue exercise of market power by the patent-holder. Conversely, compulsory licensing has a long tradition of use as part of Canada's intellectual property rights policy, most notably in the pharmaceutical industry (Pazderka 1999).

Recent research on patent policy has examined its incentive effects on cumulative research, where, over time, the patented result of one firm's R&D endeavors becomes the building block for another firm's activity. The result of such a process often includes a second patentable innovation, which may or may not infringe the first patent.[5] When it does infringe, the second patent may not be worked by either firm without the agreement of both. Here, a compulsory licence (on the first patent) would be a form of imposed agreement for the second firm to work both patents.

Even in the absence of compulsory licensing, firms may form a research joint venture in advance of second-generation research—provided that this agreement does not run afoul of anti-trust law—or they may enter into a licensing agreement voluntarily after the second-generation innovation is developed (Rosegger 1991). Scotchmer (1991) examines the

relationship between the division of the rewards from cumulative research and the incentive to innovate. Scotchmer shows that firms' incentives depend on the interaction between the optimal breadth of patent policy and the types of allowable cooperation between rival firms.

Green and Scotchmer (1989) and Scotchmer (1991) show that patent policy options based on patent breadth and life will be insufficient to encourage all cumulative research which has a positive expected social value. At the heart of this incentive problem is an external benefit conveyed to the second firm by the first-generation patent-holder. For example, the first firm's innovation may accelerate the outcome or lower the cost of the second stage, or it might enable second-generation developments which could not have (ever) otherwise occurred. At the margin, each firm's private decision to undertake a stage of R&D activity depends on that firm receiving the associated marginal benefit. However, this may not happen when the division of private benefits between firms ultimately depends on the patent policies in effect.

Two of the salient questions concerning compulsory licensing that arise from this literature are: "What will be the effects on sequential research activity of instituting a specific form of compulsory licensing provision?" and "Can compulsory license fees and other attributes be prescribed in a manner which ensures that first-generation and second-generation researchers have incentive to undertake *all* socially profitable research?" It will likely be some years before a sufficient body of industry data or case studies can be accumulated to address these questions empirically; however analytical reasoning can shed some light on the expected answers. Specifically, in the simplified case of two rival researchers advancing the same line of crop variety research, one can employ a model of firm behavior to ascertain how each would view the enactment of a compulsory licensing provision, and what role the licensing fee could play in determining the final research outcome.

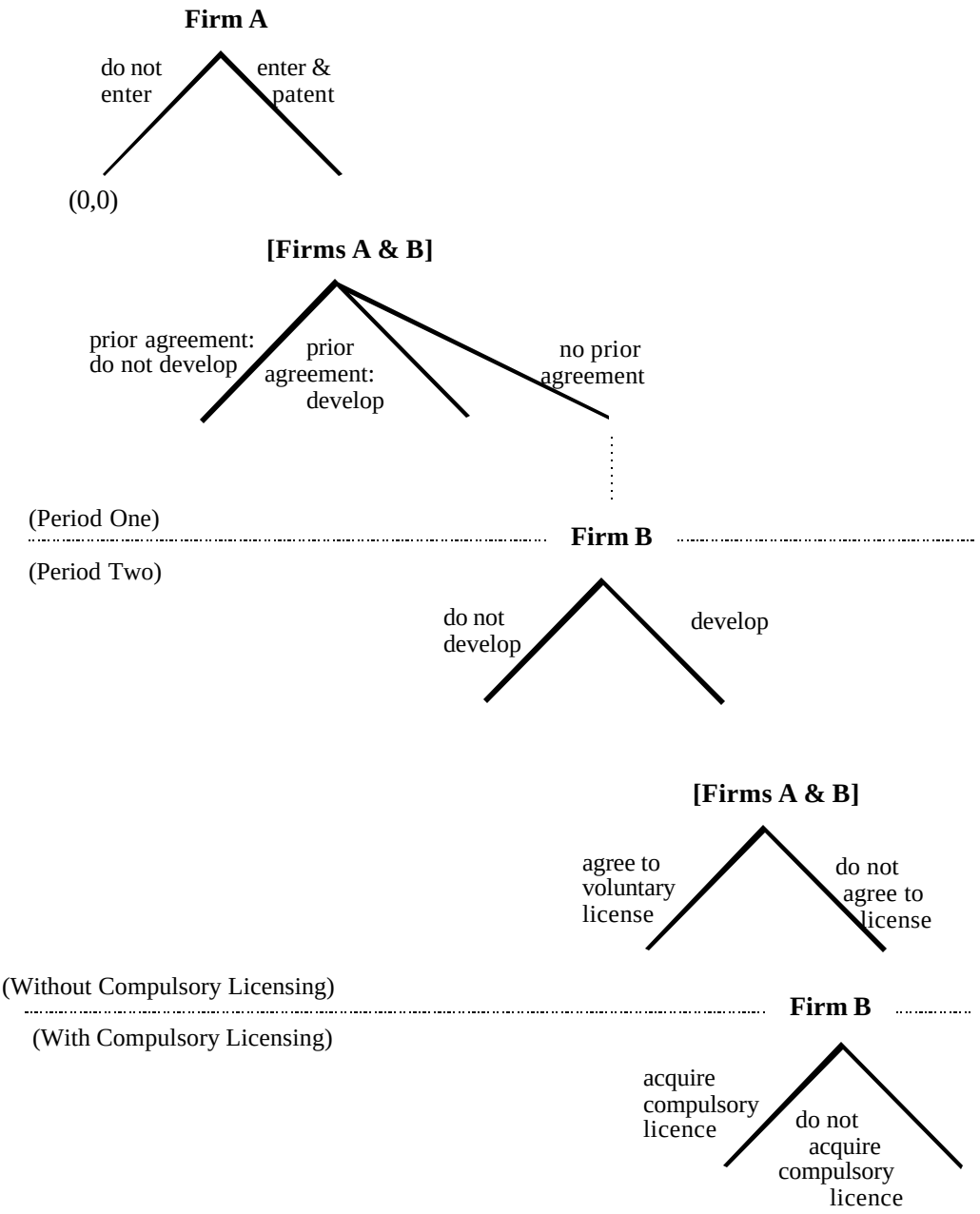
An Illustrative Model of Compulsory Licensing, Strategy and Incentives

The following stylized model allows some insights to these issues, as much from the structure it gives to the problem, as from formally calculated solutions. Consider a two-period, two-firm model, where both economic agents, Firm A and Firm B, possess the capability to undertake the same line of plant variety research. In general, the choices which are made and the outcomes which are reached will be governed by the strategic behavior of the rival firms. In this model the interaction of the two firms can be illustrated as an extensive form game, as in Figure 1.[6]

Firm A is the name of the agent with the first idea, and Firm B is the name of any other agent that gets an idea which builds upon the innovation that Firm A achieves.[7] If Firm A acts upon its idea, this will occur in first period, and the crop variety obtained can be registered without cost. Assume that, absent plant breeders' rights, imitation is costless and immediate; hence, Firm A will necessarily register. Period one is the interval during which: Firm A decides

whether to act; Firm A sells its product; Firm B gains its idea; and both firms negotiate. Period two is the subsequent interval during which: Firm B may act on its idea; both firms can negotiate further; and one or both firms can sell products.

FIGURE 1 Cumulative Research With Compulsory Licensing as an Extensive-Form Game



If Firm B acts upon its idea in period two, Firm B's crop variety will also be eligible for registration (costlessly), but it will infringe the prior rights of Firm A. If Firm A does not act upon its idea, there cannot be a Firm B, whereas if Firm B does not act, then Firm A has no market rival.[8]

The strategic interaction of the two firms is characterized by the choices (or moves) that each can make in each period. Firm A can choose whether or not to act on its idea, and, if it does, it can later choose how to respond to an overture to cooperate from Firm B. Firm B can choose whether or not to make an overture to Firm A, and can choose whether or not to act on its idea after hearing A's response.[9]

Once Firm A has acted on its idea, and once Firm B has an idea, there are three types of (enforceable) prior agreements that the firms might make before Firm B acts on its idea. First, the firms might form a research joint venture, whereby they agree to share jointly in the expected costs and benefits of developing Firm B's idea. Second, they might agree not to develop Firm B's idea, and to share in the continuing benefits of Firm A's innovation. Third, Firm A might propose not to develop Firm B's idea and not to share profits, which shall be interpreted as an agreement to disagree.

Consider next the firms' subsequent choices in the absence of a compulsory licensing provision. Firm B could choose whether or not to act on its idea without Firm A's prior agreement. If Firm B did choose to act in this case, Firm B might be able to interest Firm A in voluntarily licensing A's variety—in return for some share of the revenue—once the market value Firm B's improvement were known. In the absence (by assumption) of reputation effects associated with other players or future periods, Firm A would have no credible basis for rejecting all such offers that Firm B might propose. However, if Firm A were to reject B's ex post overture, Firm B would be prevented from marketing its product (due to A's blocking rights).

Some simplification of the game tree in Figure 1 has been introduced at those nodes where the firms must agree or disagree. Specifically, instead of showing Firm B's decision whether or not to approach Firm A, followed by Firm A's decision whether to respond (and if so, how), the firms act together to choose one of the possible outcomes. In this case, a failure to agree, or to choose, is one of the outcomes portrayed. The outcomes above the lower horizontal line describe the only equilibria which are potentially achievable in the absence of compulsory licensing.

The additional two outcomes below the lower horizontal line in Figure 1 apply to the research process in a world where compulsory licensing has been introduced. The introduction of compulsory licensing provides Firm B with one more choice ex post. That is, if Firm B has not made a prior agreement with Firm A, Firm B will be granted (upon application and with certainty) a compulsory license on Firm A's variety, enabling Firm B to market its (second-generation) innovation in direct competition with Firm A's (first-generation) product. Firm B

will be required to pay a royalty or licensing fee directly to Firm A, where the value of this fee will be determined by the IPR authorities. The method by which such a fee is set is a matter of public policy. Once the method is announced it becomes public information, which enables both firms to form expectations about the fee's value.

Green and Scotchmer (1989), in their examination of cumulative R&D and patent breadth, show that there is an important link between patent policy and cooperative agreements between rivals. Namely, the patent policy establishes the "threat points" which influence the choice of cooperative agreement, and which ultimately influence the division of profits between firms. In the context of Figure 1, the introduction of compulsory licensing and the assessment of a licensing fee constitute a change of IPR policy and thus a change of threat points.

A formal and complete analysis of this model would require specification of each firm's costs and payoffs under each outcome of the bargaining process, both with and without enactment of a compulsory licensing provision, including assumptions about whether firms will engage in vigorous price competition after a compulsory license is granted, for example. Following such an approach, the level of the compulsory licensing fee can be shown to influence the firms' choice of equilibria in predictable ways.[10]

For example, formal examination of a cumulative research model such as the one above might provide answers of the following type:

i. enactment of a (new) compulsory licensing provision alters the bargaining process between the two firms, possibly changing their relative assessments of *all* of the bargaining alternatives available to them. Even where a compulsory licensing provision were to be seldom used in practice, its introduction may well provide an important threat which will condition the negotiation and behavior of rivals;

ii. the level of fees prescribed to obtain a compulsory licence will determine how important this threat is, and will determine if and when it will be employed. In general terms, a zero (or very low) fee is likely to encourage the compulsory licensing outcome — although under specified conditions this need not occur. A relatively high prescribed fee renders incredible the threat of compulsory licensing, so that the outcomes which feature blocking "patents" or a refusal to undertake welfare-enhancing second-generation research are more likely, yet not certain, to persist; and,

iii. as shown by Green and Scotchmer (1989), a policy which allows the second-generation innovator to capture too much of the social surplus which is created may leave insufficient incentive for first-generation research. In this example, a "no-fee" policy which appears to favor Firm B, given that Firm A has entered, might discourage entry in the future by potential Firm As.

One relative strength of compulsory licensing as an instrument of intellectual property policy is the ability to target its use on the expected values of both firms' revenues and costs. It

is the *expected,* not actual, (i.e., ex ante not ex post) values of surplus that condition each firm's behavior. A compulsory licensing fee based on ex post outcomes could reduce incentives. The firm's potential receipt of windfall gains will be a prerequisite to undertaking risky research with a potential for windfall losses, even among risk-neutral firms.

An intellectual property policy that imposes the specific terms of compulsory licensing may be equivalent (in its effect on firms) to imposing a form of contract. This, on parties who are otherwise unable to negotiate a contract which provides each with sufficient incentive to undertake research capable of generating a social surplus. When a second-generation firm has made a specific investment which could be "blocked" by the first-generation rights holder, there may exist quasi-rents from having the parties agree on a contract to exploit that investment. The sharing or appropriation of these rents can lead to market failure due to *holdup* (see Hart and Moore 1988). MacLeod and Malcomson (1993) examine the efficiency of alternate contract forms with a view to isolating those which improve social welfare.

Implications for Incentive Design

The foregoing has several implications for R&D policy governing cumulative research, as in agriculture. The introduction of an intellectual property right with a compulsory licensing provision is seen to determine the incentives for both first-generation (basic) and second-generation (developmental) research in a cumulative R&D process. This incentive effect could be present even where, in practice, no applications were received for compulsory licences under the current legislative regime. The prescribed fee level, and the breadth of uses protected, are important policy instruments with the potential to determine, among other things, which types of contractual relations are established and whether there is sufficient incentive to undertake research which generates a net increase in social welfare.

For designers of IPRs, numerous other individual elements of the intellectual property rights scheme can also be modified or adapted. For example, considering the design of a compulsory licensing provision alone, there a number of alternate specifications of rights which might be conveyed, and several are considered briefly here.

Timing. Two relevant timing aspects are when a compulsory licence might first be granted and how long it will remain in force. Some jurisdictions have required a waiting period (featuring exclusive use by the rights holder) before allowing any licensing, (e.g., the plant breeders' rights regulations which were in effect in Argentina from 1935 to 1973). In terms of the two-period model, this provides a guarantee to Firm A about the minimum length of period one.

A compulsory license is more usually granted for the life of the patent or other IPRs to which it is applied, since once the original rights lapse there is no further need of a licence. A compulsory license could be issued for a shorter period of time, such as when the purpose is to

reduce the "undue" exploitation of monopoly power by the rights holder, and where there is some reason to believe that exploitation would not resume. One example might be in a market of declining size, for example.

Breadth. Just as a patent or other IPR may provide protection which is narrowly or broadly defined, so too might the license which diminishes that protection. For example, if a goal of the IPR regime were to encourage cumulative research, a provision might allow compulsory licensing *only* in the case of blocking patents or rights. That is, the "narrow" compulsory license would authorize its holder to market second-generation innovations—an act which would not be legal without the license—but does not authorize working of the first-generation patent or right. This is implicitly the form of license used in the two-stage game described in Figure 1, since Firm B was not also empowered to offer a line of Firm A's good in direct competition with A. Greater breadth of license would have allowed a licensee to do anything that Firm A could do.

Cross-licensing. As in some countries' systems, there might be provision to allow both firms to market both goods if a compulsory license is issued. If the cross-licensing option were exercised, it might serve as a form of compensation-in-kind to a Firm A, eliminating the need for an additional licensing fee. In the stylized model examined earlier, if Firm A were to gain both a fee and a cross-license, then Firm A would have a potential pricing advantage over Firm B, and only Firm A might prevail if price competition were anticipated in period two. The introduction of compulsory licensing with cross-licensing and a fee, as in this example, might provide no new incentives to Firm B's entry, and would leave the research game (as in Figure 1) the same as in the absence of compulsory licensing. [Eswaran (1994a, 1994b) examines how voluntary cross-licensing might be used by an incumbent firm to exercise its market power to choose its rivals, with related effects on industry structure and overall rates of innovation.]

Enforcement Provisions. The range of enforcement options encompasses such issues as whether there will be an enforcement agency (publicly-funded) or whether the burden of enforcement will be on an aggrieved party as adjudicated by the civil courts or other specialized tribunals. If the latter, what provision will be established for awarding costs and damages? Cost awards may act as incentives reducing frivolous lawsuits which are designed to lessen competition, whereas "treble damages," (a punitive remedy common with patents) could serve as a specific incentive not to infringe.

The enforcement provisions on the original patent or IPR might be deemed to govern if Firm B exceeds the license rights and causes injury to Firm A, whereas the enforcement provisions of the license itself may govern if Firm A (or some rival Firm C) were to infringe and cause injury to Firm B. Alternatively, the enforcement provisions on the original patent or IPR may be made to apply to both the patent and any licenses granted pursuant to it (and may further require a licensee to call on the holder to enforce against infringement of rights granted by a license). However, there may be reason to differentiate enforcement of the two sets of rights,

such as when the likelihood or effect of frivolous lawsuits is expected to vary, and a different onus or burden of proof is advised.

Exclusivity of a License. Compulsory licensing provisions may be granted to one applicant exclusively, as in the case of Firm B in the model, or they may provide for universal access by any firm to the protected product or process, subject only to payment of a fee by each licensee. Where there are a number of potential users of such licenses, the decision to allow more than one could be expected to have a significant effect on market structure in the market for the innovation covered by the license. In the stylized model, the arrival of a large "competitive fringe" also planning to market Firm B's innovation would dissipate revenues or profits and discourage entry by some potential Firm Bs. Similarly, the principles governing the determination of a "reasonable" licensing fee could be based on the size of the relevant markets under free entry, and not only on the characteristics of the Firm B seeing a license.

Method of Fee Determination. Distinct from the level of any compulsory licensing fees which are imposed, is the method by which they are set. For example, an authority might consider the firms' expected and actual market values and development costs in setting the fee. Obviously, there would be significant information required to estimate such values with some accuracy, especially if the intended incentives are to be provided. In the case where information and monitoring are relatively costly, other methods of fee determination, such as auctions or arbitration could be incorporated. There is also the possibility of setting licensing fees by a method or formula which is "state contingent." The fee mechanism might be made to depend on the relative values of various products, research costs or production costs, or it might depend on the number of firms seeking to acquire a compulsory license.

Maintenance Fees. Just as some IPR schemes feature a requirement that an annual fee be paid to the IPR bureau, so could a provision be included with compulsory licenses. That is, a licensee might be required to pay separate fees to the licensor and to the IPR bureau, where the purpose is not merely cost recovery or rent collection, but to provide certain signals or incentives. For example, a requirement for annual patent fees might discourage the exclusionary protection of products or processes which are not being worked at a significant level. If fees are not paid, the right lapses, and the protected product or process enters the public domain. The establishment of a similar fee basis for an exclusive compulsory license, for example, might allow others to acquire and work such a license if the fees were not paid.

Whatever combination of design features is chosen, the actual outcomes will, of course, depend on the particular features of each industry and technology to which they are applied. These specific policy examples are intended to be illustrative. If intellectual property rights are to fulfill their potential role as an instrument of public research policy, considerable scope exists to design them in a manner which is appropriate to each country's needs.

The Experience with the Compulsory Licensing of Plant Breeders' Rights in Canada

The application of compulsory licensing as an economic incentive in agricultural R&D will be illustrated by reference to Canada's system of Plant Breeders' Rights. Although space limitations preclude an exhaustive analysis of these IPRs, several features of the incentive design problem will be highlighted. Since August 1990, the *Plant Breeders' Rights Act* (Canada 1990, 1991) has provided a framework within which proprietary rights can be extended on a variety-by-variety basis to plants.[11] The life of these rights is eighteen years measured from the date they are issued. The focus of the legislation is on agricultural crops and ornamentals.

The creation of Plant Breeders' Rights is one means of providing domestic or foreign inventors with intellectual property rights in their discoveries. Domestically, the Act is intended to increase private and public R&D efforts in a sector traditionally dominated by the publicly-funded plant breeding programs of the federal and provincial governments and universities (see Wright and Zilberman 1993). Some of the economic or social welfare questions raised by Plant Breeders' Rights are common to the analysis of patent rights in general, but are especially salient here because of the opportunity to apply such rights on a species-by-species or variety-by-variety basis. It is also important that plant variety research is a cumulative activity, such that one firm's innovation with respect to disease resistant varieties, for example, could be adopted as the starting point for another firm's R&D efforts with respect to climatic adaptability. Other authors have addressed Plant Breeders' Rights in Canada (Loyns and Begleiter 1984; Lesser 1988) and in other jurisdictions (Lesser 1988; Stallman 1990; Pray 1992 and Tansey 1999).

The Canadian Plant Breeders' Rights legislation illustrates the challenging task of establishing a system of incentives which promotes social welfare gains, especially in a cumulative research environment. One of the ways that this PBR legislation has attempted to deal with these issues, is by providing for compulsory licensing, including a general definition of how licensing fees will be prescribed and when they will apply. The Canadian Act includes a compulsory licensing provision and calls for "reasonable remuneration" to be paid to the original rights holder when it is invoked, such as through license fees or royalties (Canada 1990, Sec. 32).[12] Presumably, a compulsory licensing provision could provide an assured means for a second-generation researcher to circumvent the potential problem associated with blocking or dependent rights in the event that private negotiation could not resolve it.

The rate of activity under Canada's Plant Breeders' Rights legislation is illustrated in Table 1. Following publication of the relevant regulations in 1991, applications for rights were received in 1992 and the first such rights were issued in 1993. By the middle of 1999, about 630 rights had been granted. Almost 60% of these had been issued for ornamental varieties; chiefly flowering plants such as chrysanthemum, poinsettia and rose.

TABLE 1 Plant Breeders' Rights Granted in Canada under the Plant Breeders' Rights Act

(from its coming into force in August 1990 until May 1999)

	Total	**Agricultural Field Crops**	**Horticultural Food Crops**	**Ornamentals**
Pre-1993	0	0	0	0
1993	51	6	0	45
1994	73	21	2	50
1995	83	29	11	43
1996	81	11	16	54
1997	132	24	38	70
1998	145	56	16	73
to May 1999	66	8	28	30
TOTAL	631	155	111	365
Percent	***100***	***25%***	***17%***	***58%***

Source: Canadian Food Inspection Agency.

The most important statistics, from the perspective of compulsory licensing, would be the corresponding number of compulsory licenses sought and granted under this legislation, and those figures are both *zero*. That is, no formal application has yet been received for a compulsory license to use any of the 631 licensed varieties. According to bureau staff, there have been inquiries made about the process but none of these has resulted in an application. Although the application process is not onerous, there is an application requirement that the applicant for a compulsory license show that he or she has been unable to acquire a voluntary license at a "reasonable fee." Since a successful applicant will be required to pay a "reasonable fee" as royalty, this requirement would seek to have the applicant show that private solutions do not exist to fill their demands for use of the variety. It is not clear what expectation individuals will have formed about an interpretation of a "reasonable fee," since there are neither precedents nor articulated definitions to follow for that purpose.

Under the currently operating version of Plant Breeders' Rights in Canada, there is a blanket relaxation of existing rights when other breeders use a licensed variety for second-generation research. Moreover, if another breeder develops an "essentially derived variety" (see below), there is no explicit requirement that the original rights holder be compensated. In terms of Figure 1, the current Canadian system is offering to second-generation researchers an outcome that is equivalent to a compulsory license without the need to apply for (or pay for) such a license. This may explain why there have been no formal compulsory license applications

for sequential research in Canada. It may also explain why the Canadian legislation does not comply with international standards in this area.

As an aside, Canada, and that portion of the Canadian legal community that specializes in IPRs, have considerably more experience with compulsory licenses than would be found in the United States, for example. Referring to Canada's experience under the *Patent Act* with its allowance for the compulsory licensing of pharmaceuticals, Pazderka (1999, 44) provides the following statistics. For the period 1923 through 1969, the *Patent Act* allowed for the compulsory licensing of "active ingredients" and 22 licenses, in total, were granted. From 1969 through 1987, an amended Act allowed for the compulsory licensing of imports of patented drugs as well as of active ingredients, and about 400 licenses, in total, were granted, mostly for imports of active ingredients.

The principal motivation of these pharmaceuticals applicants was *not* to conduct cumulative or sequential research, nor to overcome holdup associated with blocking rights, instead it was to market a competing "generic" version of the patented item in direct competition with the original. Importantly, the royalty rate was set at four percent of the net selling price of the drug in final dosage form. Interestingly, that rate was set by the courts, and not by the Act, its regulations or by any form of specialized tribunal.

These two Canadian examples suggest that, as an instrument of intellectual property policy, compulsory licenses can have both a *potential* and a significant *actual* role to play, although in the case of Plant Breeders' Rights, there is no direct regulatory evidence of those effects. The message conveyed by the strategic game described in Figure 1 is that, even in the recent history of these Plant Breeders' Rights, the compulsory licensing provision *may* be having an important effect in defining the terms under which voluntary licenses would be granted, or under which research joint ventures would be formed. Regrettably, those are economic activities that are not equally well monitored by regulatory agencies.

International Pressures on Canada's Compulsory Licensing of Plant Varieties

Canada's system of Plant Breeder's Rights, and the role of compulsory licensing within that system, is currently under review. Specifically, amendments are being proposed that could bring the Canadian system into compliance with agreements at the international level. For example, Canada is a signatory to, but has not yet ratified, the 1991 International Union for the Protection of New Varieties of Plants (UPOV) Convention. Important terms proposed to be changed include increasing the life of the protection afforded, and redefining its breadth.

Breadth is at issue in the treatment of such issues as "farmers' privilege" which, as at present, allows farmers to save and sow seed from protected varieties without infringing the IPR of the PBR rights-holder. Similarly, the 1991 UPOV Convention extends the rights of breeders

of licensed varieties to restrict the uses of the *products* of those varieties, including protections on such things as cut flowers, the ongoing production of fruit, and flour that would be milled from the harvested grain of a protected variety. Presumably, the Canadian decision on whether to adopt specific changes that could restrict some economic activities may well depend on the perceived effectiveness and fairness of the inherent compulsory licensing provisions available to remedy specific constraints.

Another issue concerning the breadth of plant variety protection is articulated in terms of "essentially derived varieties." These are varieties which are derived from a protected variety but which may not be clearly distinguishable from it. Although Canada's Plant Breeders' Rights require a new variety to be "distinct," there appears to be a need to incorporate notions of essentially derived varieties explicitly in Canadian law and to show that the interests of the original rights holder will be protected. Legal reform proposals on this point include clarifying the burden of proof when there are allegations of infringement. Importantly, there are also suggestions that Canada should expand the role of compulsory licensing, such as in situations where one is unable to negotiate reasonable terms to become a breeder of an essentially derived variety.

Under Article 27.3(b) of the *Agreement on Trade-Related Aspects of International Property Rights* (TRIPS, hereafter) member countries may exclude plant varieties from being patentable (under general patent laws), provided that these countries provide other IPR protection, such as through an effective *sui generis* system, such as Plant Breeders' Rights. The provisions of that subparagraph are due to be reviewed in 1999, and some attention may focus on the effectiveness of countries' plant variety protection laws. In the larger sphere of agricultural biotechnology R&D, the choice, by member countries, between plant variety protection and patents (or of both) as instruments of intellectual property law may be an important one, but it should be noted that plant variety protection only covers some innovative activity of interest. For example, patents may be made to cover other biological materials and processes, including isolated DNA sequences, seeds, cells, and processes, such as those used to modify plants genetically or to obtain hybrids (Tansey 1999).

Where countries choose to use a *sui generis* system as the sole IPR for plant varieties, then, as in the case of Canada, those countries may choose to employ a compulsory licensing provision—indeed they may choose to strengthen such a provision. Where countries choose to use patents as the system of intellectual property rights, then under Article 31 of the TRIPS agreement, those countries may still choose to use a compulsory licensing provision, subject to the conditions and limits specified in that article. For example, the patent-holder "shall be paid adequate remuneration in the circumstance of each case, taking into the economic value of the authorization" (Article 31(h)). Moreover, if the compulsory license allows a second-generation patent-holder to infringe, necessarily, a first-generation patent, then the first-generation patent-holder shall be entitled to a cross-license on "reasonable terms" (Article 31(l)ii).

Much continues to evolve with respect to internationally-acceptable legal constructs for intellectual property rights protection in agriculture. The need for appropriate property rights protection appears to be growing at least as quickly as the various available and effective instruments to supply it. For now, compulsory licensing seems likely to continue to be an allowable, and in some cases, encouraged element of the established policy approach. Even as legal and trade specialists are shaping those agreements that will govern future incentives for R&D in this sector, the economists' challenge will be to sharpen their own understanding and knowledge of the actual role that compulsory licensing can be made to play in this process.

Endnotes

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[2]There is concern that this role should be neither too small nor too large. For example, under IPRs, the private R&D sector might over-invest in research due to the "common pool" problem, unless the conditions associated with IPRs are optimized in some way.

[3]When the annual budgets of public research institutions are constrained, especially in the case of across-the-board budgetary policies, the receipt of annual royalty revenues can finance successful R&D programs which might otherwise have been curtailed. Similarly, royalty revenues may provide a signal to the budget-makers of the value placed by society on previous research products.

[4]Breadth of protection of a patent or compulsory license defines how similar a rival product's attributes may be before it is deemed to infringe upon the initial IPR.

[5]Scotchmer distinguishes three types of second-generation products which might result: an accessory to the first product, a stand-alone application which embodies patented features of the first product, or a bundled improvement which is designed to be integrated into the first product.

[6]See also Yi (1995) and Cabral (1996) for related modeling approaches.

[7]By assumption, there is nothing in the cumulative nature of the research activity which increases Firm A's likelihood of also being Firm B, and this possibility is ignored in what follows. The arrival rate of ideas which lead to cumulative research is sufficiently low that neither firm actively prepares to encounter a Firm C. Should one later appear, a new game is started in which Firm B(C) becomes Firm A(B).

[8]By assumption, there is not more than one rivalrous Firm B and thus no research race. Further, Firm B can only choose whether or not to act on its idea; the rate at which it does so cannot influence the availability date or market value of its product. See Scotchmer and Green (1990) for a case where Firm A may suppress its innovation with the expectation of also becoming Firm B and developing the second-generation innovation. See Green and Scotchmer (1989) for a case where Firm B's patent might not infringe. Neither paper includes compulsory licensing as an instrument of IPR policy.

[9]An enforceable "disclosure agreement" is executed (costlessly) to protect Firm B's intellectual property from piracy as a result of such communication.

[10]One solution method evaluates each firm's strategies and identifies so-called sub-game perfect Nash equilibrium outcomes. A pair of strategies will constitute a Nash equilibrium if, given the strategy of one's opponent, one would maximize one's own payoff by playing the corresponding strategy. This equilibrium will also be sub-game perfect if, as in this case, it retains this property when viewed, not only from the start of the game, but from any point during it. In this game of cumulative research under compulsory licensing, there are six potential Nash equilibria, where the determination of whether a potential Nash equilibrium is also an actual Nash equilibrium depends on the values of the expected payoffs under each outcome, which in turn will depend on firms' output prices, research and production costs, prescribed licensing fees, and so on. Using such values it is possible to evaluate private profit levels for each firm corresponding to each of the six possible outcomes, and then, under the assumption of expected profit maximization by each firm, it is frequently possible to rank these outcomes in terms of descending profitability. Where the relative rankings are based on uncertain prices or costs for which the firms are known to share the same expectations, then each firm can use the other's rankings as data in choosing a strategy. The specific results of such a method could describe the preferred equilibrium outcomes which emerge as the prescribed compulsory licensing fees are varied, for example. See Horbulyk (1992, 1993) for an example of this approach.

[11]The proprietary rights which are granted to registrants of new varieties under the Canadian Act are not patents per se—in Canada, Plant Breeders' Rights have been established under specific *sui generis* legislation. In the United States, these rights may be established under the Plant Patent Act, covering asexually propagated plants except potatoes, or the Plant Variety Protection Act, covering sexually propagated varieties and inbred lines of hybrids. Since 1985 regular U.S. patent protection has also been available to plant matter. See Stallman (1990) and Pray (1992).

[12]The Act also calls for the establishment of an advisory committee to assist in the interpretation of the expressions "reasonable prices" and "reasonable remuneration" for the purposes of compulsory licensing (Canada 1990, Sec. 73(3)).

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