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Intellectual Property and Developing Countries: Freedom to Operate in Agricultural Biotechnology

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In agricultural biotechnology, the key technologies protected as intellectual property are highly concentrated in the hands of a small number of large, multinational corporations based in North America and Western Europe ("the North"). Although many developing countries ("the South") lack the capacity to adopt these technologies, a system of international and national agricultural research centers has used them to make genetic improvements benefiting the vast majority of poor consumers. Concern is arising in the worldwide agricultural research community that the very intellectual property rights (IPRs) that have been associated with the surge of private research in biotechnology now threaten to block access to new developments to public and nonprofit researchers. This concern about current developing-country access to essential intellectual property is exaggerated and largely misdirected. The relationship between IPRs and agricultural research in developing countries is poorly understood. International and national agricultural research centers currently have far greater *freedom to operate*—the ability to practice or use an innovation—in agricultural research on food crops for the developing world than is commonly perceived.

The Misperception of IPRs

Even in developed countries, private sector agricultural research efforts concentrate primarily on a small number of crops with high commercial value. For the vast number of other crops, public and nonprofit institutions are the principal source of genetic innovation in the foreseeable future. In developed countries these institutions increasingly find their access to essential innovative inputs uncertain, unduly expensive, or at times blocked altogether (Wright 1998; Lindner 1999).

Given the minor role of the crops involved, this problem is a source of aggravation and inefficiency in the North but is in no way a serious threat to the well-being of consumers. Understandably, the international research and donor communities fear that the problems of access to intellectual property (IP) experienced in the North constitute a serious threat to the supply of food and fiber to the poor in the South. Many of the world's poor rely for sustenance on crops such as rice, beans, and cassava, which are largely beyond the focus of the private research sector and have modest commercial prospects due to low income elasticities. When major multinational corporations made some well-publicized "donations" of intellectual property to developing countries for certain noncommercial crops, they not only highlighted the usefulness of these tech-

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nologies, but also reinforced the impression of a general lack of access to modern technological opportunities for these crops.

The Consultative Group on International Agricultural Research (CGIAR) and other international and local agricultural research organizations are still supporting and conducting agricultural research and development (R&D) geared toward poor farmers and consumers, as they did during the Green Revolution. The research budgets of many of these agencies, however, are now dwarfed by those of the major corporations in the field. Major donors have encouraged the CGIAR and other international and local agricultural research organizations to negotiate with major corporations to gain access to technologies for use in agricultural research conducted in or for developing-country economies. A survey shows fairly widespread use of protected IP by CGIAR centers, in many cases without formal authorization from the patentees (Cohen et al. 1998). While confirming the extent of international researchers' use of biotechnologies, this study showed researchers to be confused about relevant IPRs and created a sense of urgency about the regularization of licensing or other IPR transfer arrangements.

In fact, IPRs are based primarily on national laws. Public and nonprofit agricultural researchers generally have freedom to operate in regions where most modern technologies are unprotected by national IPR laws. Production in the South of a crop protected only in the North is both legal and moral per se (Barton and Strauss 2000; RAFI 2000). If, however, there is significant international trade in agricultural commodities and international transfer of the technologies used in their production, identifying valid IPR concerns becomes more complex. Thus, the spatial aspects of intellectual property are pivotal to freedom to operate in agricultural research.

The Rights to Research

The principal public policy rationale for protection of intellectual property is that it provides direct, socially beneficial incentives to innovate, while also facilitating further innovation by mandating public disclosure of the patented technology. When individuals or organizations know that legal protection will enable them to recoup their research investments, they have a stronger incentive to pursue such innovations. In the absence of protection, attempts to recoup investments or to profit commercially from an innovation may fail because of imitation. Knowing this, prospective innovators may underinvest in R&D or exploit their inventions in secret. In addition, by clarifying rights to new ideas, intellectual property protection helps to reduce the costs that would otherwise be required to determine ownership of rights.

An important but perhaps underappreciated aspect of most systems of IPRs is the requirement that inventors and researchers seeking these rights disclose the new knowledge they have obtained. As new ideas are disseminated through publication, licensing, or other means, this information stimulates further rounds of innovation and technological advances.

Inherent in intellectual protection is a tension between the goal of providing incentives for innovation and that of allowing innovators to build upon one another's work. The broader the monopoly rights conferred, the larger the potential threat to the freedom to operate. Owners of a technology may be unwilling to share or license it or willing only after costly negotiations, thus making it difficult for others to obtain essential tools for advancing their own research. Moreover, owners of technology may litigate against alleged infringers, so in practice, those who hope to use a protected technology must weigh the risk of litigation against the costs of obtaining licenses.

To further complicate matters, the modern methods used to develop new crop varieties depend on a wide range of component innovations, the rights to which may be held by many competing parties—be they patent rights or use rights assigned through commercial contracts or licenses. And the number of separate rights needed to produce a new innovation will only escalate as biotechnology patents become more prevalent. If ownership of these rights is diffuse and uncertain, it can be difficult or impossible for potential users to successfully negotiate with all of the relevant parties.

Yet agricultural researchers in many developing countries are freer than one might think to make use of innovations protected in the developed countries. This is because there is no such thing as an "international patent right." Patent or other rights awarded in, for example, the United States do not *a priori* confer property rights in the rest of the world. Patents and other IPRs are awarded by national governments, and

the protection conferred by each national government applies only within that country. To obtain patent protection in several countries, innovators must apply for and gain rights in each. Table 1 shows some key agricultural biotechnologies and where they are subject to intellectual property protection. In countries where a technology is not subject to intellectual property protection, anyone is free to make, use, or sell whatever technology or knowledge is available for crops, irrespective of whether the crop is grown for subsistence or commercial use or the technology is protected elsewhere.

Table 1—Property protection status of some key agricultural biotechnologies

Technology	Property rights holder	Jurisdiction	Patent numbers
The key agrobacterium technology for plant transformation			
	Monsanto	Australia, Europe, Japan (pending), Russia, and United States (in interference)	Australian patent 559,562 B2; European patents 131,620 B1 and 131,624 B1; former Soviet Union patent 1,582,990 A3
	Max Planck Institute	Australia, Denmark (pending), Europe, Israel (pending), Japan, and United States (in interference)	Australian patent 546,542 B2; European patent 116,718 B2; Japanese patents 2,769,539 B2 and 2,726,267 B2
	AstraZeneca/Mogen	Europe, Japan (pending), and United States	European patent 120,516 B1; U.S. patents 4,940,838 and 5,464,763
	Novartis	United States	U.S. patent 6,051,757
	Japan Tobacco	Australia, Canada (pending), Europe, Japan, and United States	Australian patents 667939 B2 and 687863 B2; European patents 604662 B1 and 672752 B1; Japanese patent 2649287 B2; and U.S. patent 5,591,616
The most widely used selectable markers for cereal transformation			
Phosphinothricin, Basta®	Aventis/AgrEvo	Australia, Canada, China (pending), Europe, Finland, Greece, Hungary, Israel (pending), Japan (pending), Mexico (pending), New Zealand (pending), Singapore, South Africa (pending), and United States	Australian patents 653,845 B2, 613,367 B2, 609,082 B2, and 604,743 B2; Canadian patents 1,337,597 A1 and 1,321,364 A1; European patents 531,716 B1, 290,986 B1, 275,957 B1, and 257,542 B1; Finnish patent 100,251 B1; Greek patents 3,007,859 T3 and 3,005,200 T3; Hungarian patents 216,645 B, 217,208 B, and 215,079 B; Singaporean patent 46,682 A1; U.S. patents 5,767,371, 5,767,370, 5,668,297, 5,650,310, 5,077,399, 5,637,489, 5,276,268, and 5,273,894
Kanamycin resistance gene or G418 under control of CaMV 35S or 19S promoters	Monsanto	Europe and United States	European patent 131,623 B2; U.S. patents 5,034,322 and 6,174,724
Hygromycin resistance	Novartis	Australia, Canada, Denmark (pending), Europe, Finland (pending), Greece (pending), Hungary, Ireland, Israel (pending), Japan, Russia, and United States	Australian patents 555,574 B2, 582,653 B2, and 565,625 B2; Canadian patents 1,195,626 A1 and 1,278,540 A1; European patents 68,740 B1, 135,291 B1, and 186,425 B1; former Soviet Union patent 1,250,174 A3; Hungarian patents 195,248 B and 200,366 B; Ireland patents 8,853,521 B and 9,357,776 B; Japanese patent 2,815,837 B2; U.S. patents 4,727,028, 4,960,704, and 5,668,298
CaMV 35S promoter	Monsanto	Europe and United States (Rockefeller University)	European patent 131 623, currently being opposed; U.S. patents 5,352,605, 5,530,196, and 5,858,742

Source: Search conducted by Carolina Roa-Rodríguez for authors using the CAMBIA-IP online patent database.

The extent of freedom to operate in developing countries is not well understood. For example, the recent vitamin A rice innovation (*Golden*rice™) reportedly requires permission to practice more than 70 patent rights. The well-publicized donations by major corporations of their intellectual property relevant to vitamin A rice left a strong impression that they were relinquishing the exercise of large numbers of crucial patent rights in favor of the poor in developing countries. In fact, in some major rice-consuming countries, there are no valid relevant patents, and in most, there are very few. Similarly, the donations of virus-resistant technology for some noncommercial potato varieties in Mexico and for sweet potato in Africa apparently do not involve any patents relevant in the target countries. Finally, the Cohen et al. (1998) survey reported fairly widespread use of protected intellectual property by the centers of the CGIAR, in many cases without formal authorization from the patentees. But no distinction was drawn between patents valid in developed countries and those valid in the centers' host countries.

Though there is no international patent, international treaties and organizations do play an important role in IPR. They make it easier to extend protection to multiple countries and provide a uniform, minimal set of laws and standards that apply to all subscribing countries. Increasingly, innovators in developing countries are seeking IPRs in developed countries, and vice versa. Currently, however, in the fields of agriculture and agricultural biotechnology, the type and scope of protection varies greatly from country to country, especially between developed and developing countries. This variation makes it more difficult to assess whether there is freedom to operate on an international level.

How Production and Trade Patterns Affect IPRs

Understanding the production and trade status of crops relevant to developing countries is important not only in ascertaining the implications of IPRs, but also in assigning use rights by the private sector to public and nonprofit plant breeders. The willingness of owners of agricultural technology to cede use rights, or the minimum price at which they are willing to sell the rights to others, is shaped—among other things—by where crops are produced and traded.

Developing-world crop breeders have freedom to operate with respect to crops produced in developing countries unencumbered by local intellectual property protection of relevant inputs, processes, or products. Problems may arise, however, if those crops are subsequently exported in a form in which infringement is detectable to countries in which intellectual property protection is likely to prevail. In such cases it is the importer, not the breeder, who may be infringing on intellectual property. Binenbaum et al. (2000) studied production and trade data for 15 of the crops most important to research agencies operating in developing economies (soybeans, bananas, rice, coconuts, groundnuts, wheat, cassava, maize, beans, potatoes, chickpeas, sorghum, lentils, millet, and barley). The findings suggested the extent to which trade patterns are likely to raise IPR problems for agricultural research in developing countries:

- Exports from developing to developed countries of CGIAR crops are insignificant compared with total agricultural exports from developing countries, developed-country imports, or even domestic agricultural production, except for a few commodities and a few developing countries.
- As a group the developing countries account for more than 90 percent of the world's production of rice, millet, cassava, sweet potatoes, yams, bananas, plantains, chickpeas, cowpeas, pigeon peas, groundnuts, and coconuts (and for quite a few of these crops they account for more than 98 percent of production). They also account for more than 65 percent of the world's production of sorghum, beans, and lentils.
- For the majority of CGIAR crops, output is never traded across international borders. Soybeans, coconuts, bananas, lentils, and beans are the only crops of the 15 studied for which more than 10 percent of developing-country production is exported.
- Just two crops (soybeans and bananas) account for 64 percent of developing-country crop exports to the developed countries, and just four countries (Argentina, Brazil, Costa Rica, and Ecuador) account for 42 percent of the South-North trade in these two crops. Adding exports of rice and coconuts amounts to 80 percent of the South-North trade total, with most of the rice coming from Thailand and coconuts from the Philippines.
- The principal destination for South-North trade in 9 of the top 10 developing-country crop exports

(specifically soybeans, bananas, rice, coconuts, groundnuts, cassava, maize, beans, and potatoes) is Western Europe. Wheat is the only exception. To the extent that it is exported from developing countries, it is mainly shipped to North America and Japan. These exports are dwarfed, however, by wheat trade from North America to developing countries.

The trade data suggest that freedom-to-operate problems are most likely to arise in soybeans, bananas, and rice, but soybeans are not currently a major focus of public research by national or international agricultural research organizations working in or on behalf of the developing world. There is still substantial freedom to operate, however, for most crops of major significance for food security in poor countries. While freedom to operate in specific circumstances depends upon the claims of the IPR and its spatial pattern, crop production, and trade, IPRs over biotechnologies are mainly held in rich-country jurisdictions and are therefore primarily relevant to these jurisdictions.

IPRs in the North affect farmers in the South if they export infringing products in detectable form to the North. South-North trade in food staples is limited overall, however, and involves only a few crops and developing countries in any significant way. IPR-based limitations on export markets for food staples that embody technologies protected only in the North should not in general be considered an important impediment to the use of these technologies in such crops in the South.

This does not mean that freedom to operate is no problem for developing-country research on export-oriented cash crops such as horticultural products, tropical beverages, or dessert bananas. The Binenbaum et al. study (2000) focused on the predominant food crops of significance to poor people.

Focusing on More Urgent Problems

Undue concern about the freedom to conduct research by or on behalf of developing countries is misdirecting policy and practical attention away from the main constraints currently facing researchers on food crops for the South. The real constraints are an increasingly serious lack of investment in developing-country research and a lack of local scientific skills to access the rapidly advancing stock of complex modern biotechnologies, whether they are protected by patents or not (Pardey and Beintema 2001). Biotechnology is challenging the adaptive capacity that has enabled poor countries to benefit from the advances in plant genetics and other relevant technologies in the past half-century, and lagging public resources are not being replaced by private-sector investments. Failure to invest in the adaptive capacity needed to evaluate, access, and regulate the technologies being developed in the North is currently a far greater constraint than IPRs. The very confusion over this issue illustrates researchers' and decisionmakers' lack of capacity to handle questions relating to IPRs and freedom to operate in developing-country plant breeding.

For the future, how the World Trade Organization's Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPs Agreement) is implemented with respect to plant-breeding technology, domestically and in important export markets, is a crucial issue for developing-country policymakers. Where patenting of plant and other life forms is allowed, the patenting of key biotechnologies in the South will grow, threatening developing-country researchers' freedom to operate and freedom to trade in developing-country agricultural products, both South-North and South-South. This issue ranks with implementation of farmers' rights as an important policy concern for plant breeders, farmers, and the food consumers of the South. But *domestic* freedom to operate is generally the relevant IPR issue; exports of food staples that dominate agriculture are not important growth drivers in most developing countries.

Private corporations in the developed countries spent nearly US$11 billion on agricultural R&D in 1995 (in 1993 prices). By misunderstanding their present freedom to operate, breeders of food crops for the South threaten their ability to bargain effectively for access to the scientific outputs from OECD countries. As institutional innovations bridging the private-public divide begin to emerge (Nottenburg et al. 2002), all parties need a clear picture of the present degrees of freedom regarding Southern agricultural R&D in order to strike effective deals when tapping Northern intellectual property on behalf of the world's poor, to know when such deals are not needed, and to recognize what is being surrendered in choosing patenting rather than plant breeders' rights in implementing the TRIPs Agreement.

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For a more detailed version of this summary, see E. Binenbaum et al. 2000. http://www.ifpri.org/divs/eptd/dp/papers/eptdp70.pdf

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