Application of Intellectual Property Rights in Developing Countries: Implications for Public Policy and Agricultural Research Institutes

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[*] The opinions and views expressed herein are solely those of the author and should not be attributed to WIPO or his employer.

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List of Acronyms

AARD	Agency for Agricultural Research and Development, Indonesia
ABSP	Agricultural Biotechnology Support Project
AGERI	Agricultural Genetic Engineering Research Institute, Egypt
ARC	Agricultural Research Center, Egypt
CAMBIA	Center for the Application of Molecular Biology to International Agriculture
CBD	UN Convention on Biological Diversity
CDs	Compact Disks
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
DDJB	DNA Data Bank of Japan
DNA	Deoxyribonucleic Acid
EBI	European Bioinformatics Institute, Cambridge
EMBRAPA	Brazilian Agricultural Research Corporation
FAO	Food and Agricultural Organization (of the United Nations)
FDI	foreign direct investment
FTO	freedom to operate
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GRAIN	Genetic Resources Action International
GURTs	Genetic Use Restriction Technologies
ICAR	Indian Council of Agricultural Research
INPI	Brazilian National Institute of Industrial Property
IP	Intellectual Property
IPGRI	International Plant Genetic Resources Institute
IPP	Intellectual Property Protection
IPR	Intellectual Property Rights
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-biotech Applications
KIAT	Kekayaan Intelektual dan Alih Teknologi, Indonesia
MSU	Michigan State University
MTA	Material Transfer Agreement
NARS	National Agricultural Research System
NGOs	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
PBR	Plant Breeders' Rights
PCT	Patent Cooperation Treaty
PFC	Patent Facilitating Centre, India
PVP	Plant Variety Protection
PVR	plant variety rights
R&D	Research and Development
SAU	State Agricultural Universities
TIFAC	Technology Information Forecasting and Assessment Council, India
TRIPS	Trade Related Aspects of Intellectual Property Rights
UNCTAD	United Nations Conference on Trade and Development
UPOV	International Union for the Protection of New Varieties of Plants
USDA	United States Department of Agriculture
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Executive Summary

Implementing and managing intellectual property presents many complex decisions for agricultural scientists, research managers and policy makers. The purpose of this study is to generate critical information and conceptual knowledge on the implications of IPR decision making by public agricultural research institutions and policy makers in developing countries. The specific objectives of this paper are to provide:

1. An overview of the TRIPS Agreement and agricultural research system in developing countries
2. The status of intellectual property rights implementation in few selected countries.
3. A conceptual analysis of issues, challenges and alternative options available to policy makers, implications of such policy option and how they may be implemented.
4. A conceptual framework, which explores the issues and challenges facing administrators and managers of public research organizations, and options and implications of managing intellectual property in a public research institute.
5. A needs assessment of public sector agricultural research institutes in the area of intellectual property rights.

Overview

The TRIPS Agreement has made IPRs a trade issue and a major component of WTO. As a legally binding part of the WTO, the TRIPS Agreement provides minimum national standards for levels of protection to the creators of intellectual property. Areas which are relevant for agriculture and for which TRIPS mandates a minimum level of protection are patents, plant variety protection, commercial marks such as trademarks and geographical indications, and trade secrets.

Article 27.1 of this Agreement requires members to provide for patents "for all inventions, whether products or processes, in all fields of technology". Article 27.3(b) allows the exclusion from patentability of plants and animals but not microorganisms. It also requires member countries to provide for the protection of new plant varieties using patents, or an effective *sui generis* system, or a combination of both. One possible *sui generis* system likely to be recognized as effective is the Plant Breeders Rights (PBR) developed by the 1991 Convention of the Union for the Protection of New Varieties of Plants (UPOV).

The changes in IP protection laws are changing the roles of the public and private sectors with regard to the funding, research focus, and dissemination of agricultural R&D. They have created new opportunities and challenges for research partnership between the public and private sectors. The national and international public research institutes in developing countries are also partnering with the public and private sectors in industrial countries.

Implementation Status of IPRs

To gain some perspective on the implementation status of IPR as it relates to agriculture, the author conducted a survey by sending out a questionnaire to about 84 researchers/managers in 28 developing countries. The response rate was 32 percent, with 27 respondents returning the e-mail response. A shorter questionnaire was also sent to additional 13 researchers (with 8 returning the e-mail response) to obtain missing information on the status of implementation of IPR in their countries. Except for Israel, none of the UPOV member states from developing countries responding to the survey have yet acceded to the 1991 Act, which has a higher level of protection for PVP. Regarding the requirement of TRIPS to expand the patent law to include microorganisms, microbiological processes and microbial processes, only the technologically advanced developing countries—including Argentina, Brazil, Chile, China, Korea, Mexico and South Africa—have amended their patent laws or developed a new patent legislation to cover these subject matters. Others are proceeding with the fulfillment of their commitments to TRIPS with either a draft framework in preparation or awaiting government approval. Except for a few, all of the reporting countries who are members of WTO have established a contact point for IPR related matters. All surveyed countries that have implemented the PVP legislation also report the establishment of a national Plant Variety Protection Office, which is a parallel body to the national patent office.

The application and expansion of IPR to agriculture also necessitates organizational and institutional changes at a research institute-level. Many developing countries are in the process of implementing the IPR framework at the national agricultural research system and research institute levels. This study describes the status of these efforts in four case example countries: Brazil, India, Egypt and Indonesia.

From the survey and the case examples of institute-level capacity building, at least two clear points are emerging about the status of IPR in developing countries as it relates to agriculture. First, slowly but surely, developing countries are adopting new laws or modifying existing legislation to comply with the standards stipulated in international treaties. Second, effort to develop institutional capacity in public agricultural research systems to deal with IPR issues is progressing hand-in-hand with the national level efforts to implement new IPR policies.

Conceptual Analysis

Expanding IPRs to agriculture is still a major concern for policy makers and a constant topic of discussion and debate in public research institutes. This paper presents a conceptual analysis of the issues, challenges and options faced by developing countries in expanding their IPR framework at two levels of implementation – at the national policy level and the public research institute level.

At the national level, policy makers have to make decisions based on the objective of achieving national developmental goals (poverty alleviation, food security, expanding agricultural exports, etc.). In designing an IPR policy, they have to comply with the minimum global standards of IPR as laid down in the TRIPS Agreement (if they are members of WTO), while simultaneously safeguarding the interests of farmers and local entrepreneurs. Their decision framework encompasses all sectors of research – public and private, national and international. The goal is to make the best agricultural technologies available to local producers – whether it comes from the private sector or the public sector. Not providing protection to technologies and innovations defined in the TRIPS Agreement is not an option for policy makers of member countries. Some of the challenges facing policy makers in developing their IPR system include:

- Defining the scope of protection: Policy makers face the difficult task of defining the scope and breadth of protection (within the minimum standards framework defined by WTO) so as to maximize social welfare and to achieve certain distributional objectives.
- IPRs, biotechnology and market structure: The challenge is to have an IPR system comprehensive enough to cover technologies of modern biotechnology, without giving the corporations a monopoly power in controlling the vital inputs of agriculture.
- Recognizing farmers' rights: The rights of farmers arising from the past, present and future contributions they have made in conserving, improving and making available plant genetic resources particularly those in the centers of origin or diversity should be recognized.
- Complying with various international treaties (such as CBD), which may have conflicting requirements in terms of protecting a country's natural resources and intellectual property.

To address the challenges of developing a national IP system will require a careful analysis of the costs and benefits to the society of expanding IPRs. Some flexibility remains under the new international IPP scenario, and there are options for additional policies that also influence the availability of agricultural technologies. In principle, there are three general sets of options for policy related to IPP in developing countries:

1) **Form alliance with contesting forces;**
2) **)Exploit loopholes and ambiguities; and**
3) **Adopt additional policies to mitigate adverse impacts** such as: Strengthening appropriate competition laws, tougher application of the traditional patent principles of novelty, non-obviousness, utility, and enablement, tougher application of the statutory research or experimental use exemption, limiting the scope of patent claims and broadening the responsibilities of patent holders and, allowing for compulsory licensing of biological and biotechnology inventions.

The decision-making framework of a **public research institute** is governed by the objective of maximizing the public good within the national IPR policy framework. The issues, challenges and options facing a public research institute are therefore different from a public policy maker. Public researchers' and managers' decisions about IPR will be innovation-specific and governed by the relationship they envisage with other public and private research institutes in the development, commercialization and dissemination of that innovation.

In making decisions about the use and protection of an IP technology, a public research institute has to weigh benefits against the social costs to farmers and consumers, and the public expectation that all intellectual property created by a public research program should be made available free of cost and without restrictions. As public agricultural research programs create innovations, seek to serve the public and bring forth their products to market, partnerships with private companies are becoming inevitable. The need for a private sector intermediary to develop and market an agricultural biotechnology product makes it necessary for a public institute to seek protection of its intellectual property.

The application of IPRs in a public research institute poses complex issues and challenges on both sides of management decisions -- the **protection** of their own plant and animal technologies and the **use** of IP owned by others. In seeking protection a public research institute is faced with several rhetorical, management and decision issues:

- Should a public research institute protect its intellectual property?
- Should a public research institute protect technology XYZ or leave it in the public domain?
- What type of protection should a public research institute seek for its intellectual property?
- How should a public institute use its protected technology? Should it—license it to others to generate revenues, license it to others at zero or minimal technology fee (or royalty payment) or use it as a bargaining chip to negotiate technologies from private sector?

In making decisions about the use of protected IPs of other national or international research firms the issues that often arise are:
- Whether to license the use of a protected technology or invent around?
- What terms and conditions to negotiate with other research firms to ensure their freedom to operate?
- How to strike a favorable agreement?
- How to experiment and use products without indulging in the illegal use of other's IP?

Many of the proprietary inputs used by public research institutes have use restrictions (for research purpose only) and may create complex problems when the finished products are ready for dissemination. A clear understanding of the IPR implications of using proprietary inputs in a research program is therefore essential. In making decisions about the use and application of protected IPs the issues that need to be addressed by a public research institute are whether to license the use of a protected technology or invent around? What terms and conditions to negotiate with other research firms to ensure their freedom to operate? What should be the strategy to access scientific literature and databases? The strategic response to these issues will depend on the economics and legality of the technology involved, but also governed by the overall goal of public research, which is to provide best choices to farmers and end-users of agricultural technologies.

In order to comply with the national IPR policies and keep up with the rapidly changing rules of the game, public research institutes in developing countries have to take up many organizational and management challenges that require more human and financial resources, and knowledge, skills and expertise in non-agricultural fields of study. The challenges and options include:
- Establishment of an IP management office
- Developing negotiation skills and bargaining power
- Understanding and honoring IPR legislation and agreements
- Meeting the costs of IP management

Need Assessment

In the survey conducted by the author, the respondents from public research institutes of developing countries were asked to assess the need for external assistance in implementing the IPR framework in their institutes. Interestingly, the need to create awareness by training researchers and managers on IPR related issues, and the development of negotiation skills were identified as important "need areas" more frequently than the need for financial resources to cover the IP protection and accession costs. One of the areas identified as the most important "need area" by the respondents is the research and marketing tools to value PVP and patents. This is often a neglected area in training workshops aimed at educating researchers and managers on IPR issues. One of the possible reasons for the neglect could be the lack of availability of practical tools and methods. Decisions about patenting or seeking PVP are often based on serendipity and personal judgements of a researcher or a technology transfer coordinator.

Due to the complex nature of making IPR decisions, problem solving and decision-making in actual practice tends to be more of an art than a science. However, as more and more public research systems attempt to enter the market of intellectual properties, they will need a systematic approach to aid them in making decisions and building partnerships with the private sector on equal footings. Public research institutes, therefore, need market research that will:

- assist them in IPR investment decisions,
- recognize the rapid change in agricultural product markets,
- use a systemic rather than industry-wide approach,
- estimate the market value of patents, PVP, and other intellectual property for new and potential products
- be cost-accessible to the research institute.

Assistance in this regard is much needed and will require active participation of and collaboration of IP management offices with researchers in the social sciences units, both within or outside, of a public research institute.

Application of Intellectual Property Rights in Developing Countries: Implications for Public Policy and Agricultural Research Institutes

1. Background

1.1 Agricultural Research in Developing Countries: Persisting Challenges

Unlike in the industrialized world, agricultural research (both basic and applied) in developing countries is mostly in the public-sector domain. Government institutions and universities account, in general, for about 90% of formal research expenditures (Pray and Deininger-Umali 1998). Public sector programs cover the entire range of agricultural research, such as genetic resources, food, feed and fiber crops, livestock, forestry, fisheries, soil management, integrated pest control, post-harvest systems, and conservation of natural resources.

Agricultural research has been a major contributor to agricultural growth and economic development all over the world. Crop improvement research that led to the Green Revolution in wheat and rice in the 1960s to 1980s, in particular, has been a major success story of the public research systems—both national and international. As a result of agricultural research that led to the Green Revolution, there has been an unparalleled increase in food at lowered prices (McCalla and Brown 2000) and the benefits have been equally shared among the urban and rural poor.

Despite past successes, many developing countries throughout the world continue to experience food insecurity, poverty and malnutrition. The food insecurity problem, defined as *the inability to provide adequate food supplies to maintain a needed level of "per capita consumption" and to meet the nutritional requirements of all segments of the population,* of about 70 of the world's poorest countries is projected to persist in the next 20 years (USDA 1997). Many developing countries, especially in Africa, are projected to remain a global "hot spot" for hunger and malnutrition for many years to come. In Sub-Saharan Africa, an estimated 344 million people presently have insufficient food to meet minimum daily nutritional requirements. By 2010, this number is projected to increase to 435 million, an increase of over 20 percent (Rosegrant et al. 2001).

A major concern in food deficient countries is whether the agricultural sector will have the ability to produce adequate food and fiber, or the economy will have the ability to import needed food and fiber to support the rapid population growth. Economists have estimated that a 3% annual growth in crop yields will be needed over the next two decades to provide an adequate food supply at affordable prices for the growing rural and urban populations in developing countries (Rosegrant et al. 2001). Agroclimatic constraints to yield increases are however informidable in many developing parts of the world. Drought, high temperatures, and low fertility soils predominate in extensive parts of Africa, Asia and Latin America.

An infusion of new technologies that can transform an economy from subsistence agriculture to a more productive commercialized system is an essential component of the solution to projected food insecurity, malnutrition and poverty. Agricultural systems must be revitalized in such a manner that newly developed technologies can be integrated into the cropping systems without degrading natural resources and the ecology. Due to globalization and trade liberalization, developing countries are faced with the challenge of revitalizing their agricultural systems such that their farmers can compete in a global economy. Competitiveness in a global economy will be based on farmers' ability to produce and profitably market his/her products at a low price, to provide important quality traits in the desired market classes and to supply the needed volumes to meet both the processing and consumption demand for agricultural products.

Agricultural research in developing countries is thus continually faced with the challenge to:

- Reduce hunger through increased household food security
- Improve the health and nutritional status of growing populations
- Expand employment/entrepreneurial opportunities for both urban and rural poor to generate income
- Increase the competitiveness of small-scale farmers in domestic and global markets
- Conserve natural resources and thus assure the sustainability of agricultural systems

1.2. The Changing Environment for Public Research

Many changes in the international policy arena and trends in technology research have contributed to reshaping the environment for public research in the 1990s. In recent years, the value of intellectual property in the research and development (R&D) sector in general, and the agricultural research sector in particular, has increased considerably. Concerns about the piracy and counterfeiting of intellectual property have been increasingly raised in industrialized countries, where much of the intellectual property resides. As a result of these concerns, the protection of intellectual property was a major topic of negotiation at the Uruguay Round of the General Agreement on Tariffs and Trade (GATT).

The outcome of the negotiations was the establishment of the World Trade Organization (WTO) to administer the GATT, the Trade Related Aspects of Intellectual Property Rights (TRIPS) and the General Agreement on Trade in Services (GATS). The TRIPS Agreement is an integral and legally binding part of the WTO that requires all member countries (142 countries as of July 2001) to grant patents for inventions in **all fields of technology.** It obliges them to protect plant varieties either by patents, by "an effective *sui generis*" system or by a combination of both. Conformation to the TRIPS agreement for most, if not all, member countries implies introducing much stricter intellectual property protection (IPP). This is expected to have far reaching consequences on the international transfer of technology and trade relationship between the industrialized and developing countries, especially in agricultural research.

The increasing importance of biotechnology, and the privatization and consolidation of the agricultural research firms in industrialized countries were some of the forces behind the growing international pressure to establish the WTO and to harmonize (by adopting broader and stricter) intellectual property rights (IPR) under the TRIPS agreement. Biotechnology innovations are often proprietary in nature and reside in the private sector of the industrialized world where the legal framework is well developed in granting IPP to biological innovations. A growing number of research inputs are also protected as intellectual property. Because these innovations are privately owned, managed and protected through patents, plant variety protection, trademarks, copyrights, and trade secret laws, they have restrictions placed on their use during the research and/or commercialization stage.

Agricultural development in developing countries has, in the past, benefited from the wide availability of plant and animal genetic resources, freedom to operate with the most modern scientific methods, and technology spillovers. However, the already expanded IPR regimes in the industrialized world and the IPR changes required by the TRIPS agreement in the developing world is expected to have profound implications on the way scientists exchange materials and ideas, and especially the way agricultural research is organized.[1]

The issues of IPRs in agriculture are complex, involving a range of stakeholders with a diverse set of views, bargaining positions, and vulnerabilities. Implementing and managing intellectual property thus presents many complex decisions for agricultural scientists, research managers and policy makers. Many developing countries are in the process of modifying their IPR systems and in many public organizations, offices of intellectual property have been set up or are in the process of being established to help with the IPR decisions. The current state of knowledge about the direct and indirect effects and implications of stronger IPR regime on the public sector agricultural research is, however, not adequate to help these offices address the complexity of decision making faced by public agricultural research institutions.

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[1] IPRs in agriculture includes broad category of products, such as pesticides, fertilizers, animal health products, etc. (in addition to local genetic resources and associated local knowledge system). This paper deals more specifically with improved plant and animal genetic resources used for food and agriculture instead of the broad category of agricultural products. The latter are predominantly in the private sector and are not affected in a major way by the expanded IPR regimes.

1.3. Purpose of this Study

This study proposes to generate critical information and conceptual knowledge on the implications of IPR decision making by public agricultural research institutions and policy makers in developing countries. Specifically, it provides

1. An overview of the TRIPS Agreement and agricultural research system in developing countries[2]
2. The status of intellectual property rights implementation in few selected countries.
3. A conceptual analysis of issues, challenges and alternative options available to policy makers, implications of such policy option and how they may be implemented.
4. A conceptual framework, which explores the issues and challenges facing administrators and managers of public research organizations, and options and implications of managing intellectual property in a public research institute.
5. A need assessment of public sector agricultural research institutes in the area of intellectual property rights.

The paper is based on the review of existing literature on the subject and a sample survey conducted with relevant persons in the area of agricultural research in a few developing countries. Sections 2 to 6 basically address each of the objectives listed above. The final section summarizes the findings and draws implications for further research in this area.

2. An Overview of IPRs, the TRIPS Agreement and Agricultural Research System

[2] . The paper deals with agricultural research resulting in NEW technologies (e.g., methods and outputs of conventional breeding, genetic engineering, molecular biology, tissue culture, genomics, etc.). Hence the emphasis is on the TRIPS agreement (and the UPOV convention) rather than other international treaties and agreements (e.g., CBD).

2.1 Intellectual Property: What is it and Why it is Important?

Intellectual property right is a broad term used to cover patents, trade marks, plant breeders rights, copyright, trade secrets and other types of rights that the law gives for the protection of investment in creative effort and knowledge creation. Knowledge, unlike a physical object, can be used by others. The greatest level of economic efficiency occurs with the widest possible dissemination of new knowledge. But if everybody is free to access new knowledge, inventors have little incentive to commit resources to producing it. IPRs (temporarily) transform knowledge from a public good into a private good. Through enhanced market power conferred by the IPRs, owners of intellectual property can recoup their expenditure in creating new knowledge. Creative minds and innovative firms thus have an incentive to engage in inventive activities. IPRs are thus a "compromise between preserving the incentive to create knowledge and the desirability of disseminating knowledge at little or no cost" (World Bank, 1999, p. 33).

This utilitarian argument provides the main rationale for the protection given by patents, copyright, plant breeders' rights, trademarks, and several other types of IPRs (Box 1). The various forms of intellectual property differ in terms of the subject matter that may be eligible for protection, the scope and duration of protection, and possible exemptions to exclusive rights--reflecting society's objective to balance the interests of producers and users of intellectual works.

In a global, knowledge-based economy, IPRs are key to the international competitiveness of both nations and firms (Langford 1997). International competition in traded goods increasingly contains a high degree of innovation. IPRs have thus become a trade issue and a major component of WTO. Adequate IP protection at an international scale has become essential for appropriating global revenue streams to support investments in developing state-of-the-art technology.

2.2 TRIPS Agreement and its Implication for Agriculture

The TRIPS Agreement is one of the 3 pillars of the WTO--the others being trade in goods (GATT) and trade in services (GATS). The TRIPS Agreement includes for the first time in any area of international law rules on domestic enforcement procedures and remedies. A major reason for placing IPRs in the WTO and for tying the three agreements together was to allow retaliation across agreements. Under this institutional arrangement, IPRs are subject to the binding dispute resolution procedure of WTO. A non-compliant WTO member can face trade sanctions in any area if they fail to live up to the TRIPS Agreement.[3]

As a legally binding part of the WTO, the TRIPS Agreement provides minimum national standards for levels of protection to the creators of intellectual property. It covers: copyright and related rights, trademarks, geographical indications, industrial designs, patents (and plant variety protection or PVP), layout designs (topographies) of integrated circuits, protection of undisclosed information, and control of anti-competitive practices in contractual licenses (WTO legal texts pp.370-386). Areas which are relevant for agriculture and for which TRIPS mandates a minimum level of protection are patents, plant variety protection, commercial marks such as trademarks and geographical indications, and trade secrets.[4]

Table 1 gives an overview of the key issues involved in the TRIPS Agreement with respect to patents and plant variety protection. A salient feature about geographical indications used on wines and spirits is that they are given an absolute level of protection where use is prohibited. Similarly, trade secrets are, for the first time in international law, accorded the status of IPR. The TRIPS Agreement considerably strengthens the trade secret law by extending the liability to third parties that induced breach of a trade secret. Furthermore, under the TRIPS Agreement, “test data submitted for obtaining marketing approvals of new pharmaceutical and agricultural chemical products is protected against unfair commercial use” (Watal 2000, p. 54).

Article 27.1 of this Agreement requires members to provide for patents "for all inventions, whether products or processes, in all fields of technology" (Table 1). Article 27.3(b) allows the exclusion from patentability of plants and animals but not microorganisms. It also requires member countries to provide for the protection of new plant varieties using patents, or an effective *sui generis* system, or a combination of both.

The scope of patents

In plants, patents may apply to a variety of biological, non-biological and microbiological materials and processes, including:

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[3] Without a means of settling disputes, the WTO would be worthless because the rules could not be enforced. The WTO’s dispute resolution procedure underscores the rule of law, and it makes the trading system more secure and predictable. The system is based on clearly-defined rules, with timetables for completing a case. For more information on the rules and procedures for settling disputes as agreed upon at the Uruguay Round, the readers can visit the following web site: http://www.wto.org/english/thewto_e/whatis_e/tif_e/disp1_e.htm

[4] One of the products in which trade secrets are applied in agriculture relates to hybrids. With the PVP, the trend is to protect the parental lines by trade secrets and the hybrid seed itself by PBR. Geographical indications also have important applications as it relates to agriculture in developing countries. This is evident from the recent controversies on the use of the word “basmati” for protection of a rice variety, and the use of the word “Darjeeling” for tea products.

- Isolated DNA sequences that code for certain proteins;
- Isolated or purified proteins
- Seeds
- Plant cells and plants
- Plant varieties, including parent lines
- Hybrids
- Processes to genetically modify plants and
- Processes to obtain hybrids

The patenting of genes extends the scope of protection to all plants, which include a cell with the claimed gene. This could threaten commercial breeding, especially with broadly drafted patents. In the case of process patents, the patentee may prevent the use of the process as well as the commercialization of a product "obtained directly by that process". Thus if a process to produce a plant (e.g. by genetic engineering) is patented, exclusive rights would also apply with respect to the plants obtained with the process. Article 34.1 also places the burden of proof in process patents on the defendant to show that a product is not produced by the patented process.

Generally speaking, patents give patentees the right to prevent any commercial use of the materials, including for research and breeding purposes. But according to Article 30, WTO members may provide limited exceptions to the exclusive rights conferred by a patent, provided it does not conflict with a normal exploitation of the patent. This provides some flexibility in drafting patent legislation and may allow members to include exemption for research purposes. WTO members are also free to determine what 'invention' means, how novelty and inventive steps are interpreted, and the scope of claims that will be admitted.

Other exceptions permitted by the TRIPS Agreement to the basic rule on patentability include:

- Inventions dangerous to human, animal or plant life or health or seriously prejudicial to the environment (Article 27.2). Thus a country can prevent the commercial exploitation of the invention to protect *ordre* public (public policy) or morality.
- Diagnostic, therapeutic and surgical methods for the treatment of humans or animals (Article 27.3(a))

The sui generis system option

The "*sui generis"* system of protection is a special system adapted to a particular subject matter, as opposed to protection provided by one of the main systems of IPR, e.g., the patent or copyright system. The Latin term "*sui generis*" meaning "of its own kind or class" leaves broad scope for interpretation. It means that countries can make their own rules to protect new plant varieties with some form of IPR, provided that such protection is effective. The Agreement, however, does not define the elements of an effective system.

Although countries have considerable room to develop their own "*sui generis*" system, developing an appropriate *sui generis* system is a challenging task (Leskien and Flitner1997). Many countries are working on such legislation. Basically, to be in keeping with TRIPS the system should:

- Provide a legally enforceable right that either excludes others from using the protected plant variety, or enables owners to be paid for certain uses of the plant variety by third parties.
- Treat nationals of other WTO member states no less favorably than their own nationals for protection of plant varieties.
- Provide any advantage, favor, privilege or immunity granted by a member state to the nationals of any other country immediately and unconditionally to the nationals of all the other member states (most-favored-nation treatment).
- Include enforcement procedures capable of acting against any act of infringement of the *sui generis* right.

One possible *sui generis* system likely to be recognized as effective is the Plant Breeders Rights (PBR) developed by the 1991 Convention of the Union for the Protection of New Varieties of Plants (UPOV) (Box 2). The UPOV system produces quite a strong IPR regime for plant varieties. The UPOV Convention gives sufficient flexibility to its member States to adjust their national legislation taking into account their specific national circumstances. If this flexibility still does not suit, the alternative is for countries to develop their own solution and special legislation protecting plant varieties appropriate to their situation. Countries must define what the scope of the system will be. This must cover: the definition of "plant variety", the conditions under which protection is granted, the scope of the rights conferred, the definition of materials to which these acts refer (such as research exemption, breeders' exemption and farmers' exemption), and the time for which the right exists.

2.3 Public Agricultural Research in Developing Countries: Some Facts, Trends and Emerging Issues

As noted earlier, agricultural research in developing countries is predominantly the domain of public institutions. These institutions (including national and regional research institutes and agricultural universities) comprise the National Agricultural Research System (NARS), which, since the 1960s, have been supported by international centers administered under the Consultative Group on International Agricultural Research (CGIAR).

The sums of money allocated to agricultural research in developing countries are considerable, accounting for more than half of all global public agricultural research investments (Pardey et al. 1997). For the early 1990s, the estimated annual expenditures in the developing countries of Asia were about US$1.3 billion; in Sub-Saharan Africa, $500 million; in Latin America, $650 million; and in West Asia and North Africa, $400 million. Including the expenditure by CGIAR centers of $350 million, the annual agricultural research expenditures for and by developing countries were about $3 billion at the start of the 1990s (Tabor 1998).

As a share of gross domestic product (GDP), Africa allocated 0.3 percent of GDP to agricultural research, Asia 0.1 percent, and Latin America 0.05 percent (Tabor 1998). On average, developing countries allocate 4 to 10 times more of their limited resources on agricultural research than do the higher-income OECD countries. Also, the overall proportion of public expenditures assigned to agricultural research by developing country governments is higher than accorded by OECD governments. In early 1990s, OECD governments allocated 0.17 percent of public funds to agricultural research compared with 0.23 percent in Latin America, 0.6 percent in Asia and 0.7 percent in Africa (Tabor 1998).

Although agricultural research receives higher priority in government budgets, the rate of growth in public investment has declined sharply over the last three decades. In developing countries, the growth rate of public investment in agricultural research fell from 6.4 percent in the 1970s to 3.9 percent in the 1980s (Pardey et al. 1997). During the late 1980s and early 1990s, some of this shrinkage in domestic support was partly supplanted by an increase in donor funding for research, but in more recent years overall donor funding has declined and spending priorities have shifted away from agricultural research. Growth rate of real funding for the CGIAR centers supported by international donor community, decreased from 14 percent per year in the 1970s to less than 1 percent per year between 1985 and 1996 (Pardey 1997).

The slowdown in the growth rates of public agricultural research funding is of particular concern, especially since a broad array of empirical evidence shows that in the past such investments have generated annual rates of return well in excess of 30 percent (Alston et al. 1998). The major emphasis in the public sector has been to raise the productivity of crops and livestock through plant and animal breeding and developing associated technologies. In food crops at least, this has resulted in an international effort in plant breeding based on a free international exchange and use of improved parental materials and varieties. This system has resulted in a drastic increase in agricultural production in many countries, known as the "Green Revolution". The system depends to a large extent on the free availability of research results. For a long time, no restrictions have been imposed on the distribution of interventions and plant varieties among research institutes and farmers. Even the private sector has also been beneficiaries of public research whose results were made available to them without any restrictions.

The private sector has generally played a smaller role as both a funder and performer of research in developing countries. But in developed countries, the private sector amounts to almost half of total agricultural research expenditures

(Pardey et al. 1997). The increasing share of private sector investment in agricultural research has been partly a result of expanded intellectual property rights over biological innovations. The emerging modern biotechnologies are also an important element in this expansion. In industrialized countries, private investments in plant breeding, veterinary, and pharmaceutical research, which are more directly affected by advances in biotechnology, have increased substantially during the last decade or so.

One of the justifications for expanding IP protection to agricultural technologies in developing countries is that it will increase private investment in agricultural research. However, the private sector has a very different agricultural research focus from that found in the public sector. For example, in five OECD countries with largest agricultural research industry, over 80 percent of public research, but only 12 percent of private research, is devoted to farm-level technologies such as improved crop and livestock production practices (Pardey et al. 1997). A major emphasis of private sector research in these countries is on post-harvest technologies and chemical research on fertilizers, herbicides and pesticides.

The ability to protect intellectual property gives public institutes an opportunity to increase the source of funds, as well as provide incentives to researchers to produce innovations. The changes in IP protection laws is also changing the roles of the public and private sectors with regard to the funding, research focus, and dissemination of agricultural research. It has created new opportunities and challenges for research partnership between the public and private sectors. The public-private sector partnerships in agricultural research are taking many new forms (Lesser et al. 2000). For example, private sector is investing in input industries in developing countries (e.g., Monsanto’s purchase of Brazil’s Agroceres) and supporting research activities of the type previously financed by the public sector (for e.g., Monsanto and Syngenta’s ’ rice genome projects). The national and international public research institutes in developing countries are also partnering with the public and private sectors in industrial countries (e.g., Brazil and USDA collaborative program, Egypt’s genetic research institute—AGERI and Michigan State University collaborative program, partnership between AGERI and Pioneer Hi-Bred International) (Lewis 2000).

These new partnerships have raised issues for both the public and private sectors. For the private sector the issue is one of maintaining control on the outcomes of the partnership and recouping investments. For the public sector, the issue is that of fulfilling the public sector mission. Stronger IPR regime is affecting the mission of public research in several ways. Lesser et al. (2000, p. 16) note the following effects of IPR on public sector research:

- It discourages the practice of “open science” since the opportunity to patent a discovery is lost when it is publicly revealed (based on the novelty criteria). A research contract with a private firm also acts as a limitation in the publication of results

- It gives an institution control over the use of employee's innovations, including the right to grant exclusive licenses
- It restricts the ability of the researcher to further the commercialization process of a product that was developed using materials provided under a research Material Transfer Agreement (MTA)
- The broadened scope of IPRs in the area of plants and agriculture means that a scientist's research using patented tools could be infringing IPRs and could lead to possible legal action.

The institutional and technological shifts resulting from the increasing trend of protecting intellectual properties mean that current innovations of public research programs often rely on initial patents held by a number of different firms, or an initial patent held by a firm with a strong market power. In the first case, the costs of negotiating an agreement with all initial patent holders may be so high as to prevent commercialization. In the latter case, the initial patent holder has power to restrict or prevent commercialization or dissemination of products made with its technology. For example, there are two primary means of inserting genetic material into a plant. For plants such as soybeans, tomato and cotton the preferred method is by using Agrobacterium tumefaciens; for plants not readily infected by this bacterium (such as wheat, maize and rice), breeders use a ballistic "gene gun". Each of these methods is patented. Thus, a public researcher that develops an improved variety using these patented tools which has the potential to alleviate vitamin deficiencies, for example, may be prevented from disseminating this variety if it is not in the interest of the genetic insertion patent holder.

The public agricultural research systems in developing countries are thus in a predicament. On the one hand they need to sustain and enhance the quality and productivity of natural resources to meet the growing domestic demand and on the other hand, they need to ensure continued free access to the emerging technologies for a large number of subsistence farmers. In both instances, the new biotechnologies would be of considerable value. The challenge for developing countries is to implement an IPR system that encourages public sector to partner with and access new technologies from the private sector, without denying the access of it to the poor farmers.

3. Status of Intellectual Property Rights Implementation in Developing Countries

3.1 General overview

In the light of increasing pressures from international community, a number of developing countries began the process of strengthening their legal regimes for intellectual property and supporting institutions beginning the late 1980s (UNCTAD 1996). However, these changes were still not within the standards of the TRIPS Agreement. According to Article 71 of the TRIPS Agreement, the deadline for implementing the suggested changes was January 1, 2000 in developing countries (plus five additional years allowed for the implementation of protection for product patents in new areas of technology), and another five years for least developed countries.

To gain some perspective on the implementation status of IPR as it relates to agriculture, a survey was carried out by sending out a questionnaire (via electronic mail) to about 84 researchers/managers in 28 developing countries (Annex 1). The response rate was 32 percent, with 27 respondents returning the e-mail response. The survey questionnaire included questions on the status of the implementation of IPR laws, national-level institutional development, and personal assessment of respondents on some of the issues and challenges in IPR as they relate to public research. The objective of this survey was not to compare countries, but to review, in a preliminary way, the existing state of IPR regimes in countries at different levels of development and assess possible needs of these countries in the implementation and expansion of IPR framework. A shorter questionnaire requesting only the information on the implementation status of IPR was also sent (via e-mail) to additional resource persons and national PVP offices in 12 countries (Annex 1).

Table 2 gives a summary of the status of the implementation of the plant variety protection and patent protection in selected countries based on the survey responses and information obtained from published sources. The progress in implementing plant variety protection in developing countries is further ahead than the implementation of patent protection on microorganisms, non-biological processes and microbial processes (labeled as biotechnology products and processes in Table 2), and plants. The popular option for protecting plant varieties among developing countries is the protection of Plant Breeders Rights (PBRs) (a *sui generis* system of protection for plant varieties).

All countries that are members of the UPOV convention have a PVP system in place and implemented. This includes the following developing countries Argentina, Bolivia, Brazil, Chile, China, Colombia, Ecuador, Israel, Kenya, Mexico, Panama, Paraguay, South Africa,Trinidad and Tobago, and Uruguay . Some non-UPOV developing countries have also implemented PBRs, such as Republic of Korea, India, Morocco, Peru, Thailand, Venezuela and Zimbabwe. It is interesting to note that except for Israel, none of the UPOV member states from developing countries have yet acceded to the 1991 Act, which has a higher level of protection for PVP. However a number of developing countries have laws which conform to the requirements of the 1991 Act although they have not yet acceded to the treaty e.g. Morocco, Peru, Republic of Korea and Venezuela.

Regarding the requirement of TRIPS to expand the patent law to include microorganisms, microbiological processes and microbial processes, only the technologically advanced developing countries—including Argentina, Brazil, Chile, China, Korea, Mexico and South Africa—have amended their patent laws or developed a new patent legislation to cover these subject matters. Others are proceeding with the fulfillment of their commitments to TRIPS with either a draft framework in preparation or awaiting government approval. The delay or reluctance in implementing the PVP or patent legislation in many countries that have advanced agricultural research systems reflects the intense public debate in their countries on the IPR issues and the desire of the government to provide adequate safeguards to protect the interest of the people.

The interest in providing patent protection to plants is low in most countries. Even the technologically advanced developing countries that have the PVP and patent law for protecting biotechnology products and processes in place have taken no steps towards implementing a patent protection for plants as they are under no pressure or obligation to provide these rights. Patenting of life forms such as plants and animals is currently not part of the TRIPS Agreement, although it is believed to be a subject of review to have been taken place at the end of 1999.

Implementing a broad IPR framework also makes it necessary for developing countries to expand their national organizational and institutional framework. For example, Article 69 of the TRIPS Agreement requires Members to establish and notify contact points for the purposes of cooperating with each other with a view to eliminating international trade in goods infringing intellectual property rights. Except for a few, all countries reported in Table 2 who are members of WTO have established a contact point for IPR related matters.

All surveyed countries that have implemented the PVP legislation also report the establishment of a national Plant Variety Protection Office, which is a parallel body to the national patent office. The function of such office is to oversee the national policy and management aspects of implementing PVP legislation, including the processing of applications and granting of the PVP certificates.

The application and expansion of IPR to agriculture also necessitates organizational and institutional changes at a research institute-level. It requires that an agricultural research institute have part- or full-time IPR and technology transfer coordinator/manager, that it establishes an IPR or technology transfer office, and develop institutional IPR policies/guidelines/handbooks. Many developing countries are in the process of implementing the IPR framework at the national agricultural research system and research institute levels. Below we describe the status of these efforts in a few selected countries.[5]

[5] The case studies provide examples of the implementation of the IPR framework at an institute-level within a country. It should be noted that there may other independent IPR offices in other parts of the agricultural research system within a country (e.g, universities and regional research centers) which may be operating with a different IP framework and with a similar or different role than described for the case study institutions.

3.2 Implementation of IPR Framework by National Agricultural Research Systems in Developing Countries: A Few Case Examples

Brazil: Implementation of IPR Framework at EMBRAPA[6]

Since Brazil signed the TRIPS Agreement in 1995, the Brazilian Agricultural Research Corporation (EMBRAPA) has been actively involved in developing and implementing a new, internal policy for intellectual property protection. EMBRAPA is a public research institution associated with the Ministry of Agriculture and Food Supply and is comprised of 39 units/departments dedicated to agricultural R&D. In 1996 EMBRAPA added a new "Institutional Policy for the Management of Intellectual Property Rights" (IP Policy) to its statutes to give researchers some guidance on IPR issues.

The purpose of this IP policy was to facilitate the transfer or licensing of products and technologies, such as cultivars, genes, molecules, software and other products and to give guidance to researchers on IPR. The IP policy also encourages research units to seek protection for technologies, processes, and products derived from its research program.

A three-tier mechanism is in place at EMBRAPA to help in the implementation of the IP policy:

1. *A national committee, composed of representative members of EMBRAPA's research and management staff:* This committee was established in 1997 and has played an important role in the initial deliberations about general policies and other IP issues relating to processes, products and technologies developed by EMBRAPA's research programs. The committee prepared guidelines and mandatory documents to make researchers more aware of their responsibility to safeguard information and maintain confidentiality with consultants, grantees, short term visitors, and students. The committee also worked on developing guidelines about the use of laboratory books to assure an eventual verification of data. Furthermore, it organized explanatory courses and videoconferences during the first two years to raise awareness among researchers and clients on IP rules and regulations.

2. *Local committees in every research center:* These committees are responsible for reviewing patent or cultivar applications and for determining which shall be filled for protection or be exempted from the process. Scientists can approach the local committee for advice regarding the disclosure and dissemination of information.

3. *A centralized unit or IP Secretariat:* The IP Secretariat was formed in 1998 and serves as a general coordinating structure for the management of EMBRAPA's

[6] The summary draws heavily from Maredia, Erbisch and Sampaio (2000), Sampaio and Cunha (1999) and Sampaio (2000).

proprietary assets and for the licensing of third parties' assets. In addition, it serves as the policy-making body with responsibility to continuously update the IP Policy, in line with rapid global developments in the field. The IP Secretariat also participates in national discussions related to intellectual property such as the ongoing negotiations for TRIPS review and the adaptation of intellectual property matters as necessary for the implementation of the Convention of Biological Diversity (e.g. indigenous knowledge).

During the past year or so, the rationale for having a national IP Committee has diminished somewhat as the IP rules are becoming firmly internalized and the IP Secretariat is taking on more responsibilities. On the practical side, the Secretariat works as an operational body, dealing with patents, trade mark, copyrights, variety protection and technology licensing (in and out) but only when intellectual property rights are involved. One of the tasks for EMBRAPA and its IP Secretariat has been to develop and implement a set of regulations to adapt the operation of its breeding program and seed business to the Variety Protection environment.

India: IPR Capacity Building

<u>Department of Science and Technology Initiatives:</u> In 1995, as a first step to provide Indian scientists with information, orientation and facilities for protecting the products of their intellectual prowess, the Department of Science and Technology set up a Patent Facilitating Center (PFC) (http://www.indianpatents.org) under the Technology Information Forecasting and Assessment Council (TIFAC) (http://www.tifac.org.in). The objectives of the Patent Facilitating Center are to:

1. Introduce patent information as a vital input in the process of promotion of R&D programs.
2. Provide patent facilities to scientists and technologists in the country for Indian and Foreign patents on a sustained basis.
3. Keep a watch on developments in the area of IPR and make important issues known to policy makers, scientists, industry etc.
4. Create awareness and understanding relating to patents and the challenges and opportunities in this area including arranging workshops, seminars, conferences, etc.

Major Indian scientific establishments have in-house facilities to provide patent support to their scientists. However, such facilities are not available to most of academic sector and smaller scientific institutions whether in the Central or the State sector. PFC was created as a single window facility to service this large all India clientele and to reach out to remote universities and R&D centers. Scientists across universities and research institutes in India now have a direct and easy access to PFC's complete coverage.

IPR Capacity Building within ICAR: The Indian Council of Agricultural Research (ICAR) is the largest and most important body of the Indian public agricultural research system. It consists of 45 research institutes, 4 bureaux, 9 project directorates, 30 national research centers, and 79 All India Coordinated Research Projects, located throughout the country, mostly at 29 State Agricultural Universities. (Mishra 1999). The ICAR, along with other agricultural research centers and universities has been providing technical inputs to government agencies on protection of intellectual properties in the wake of the TRIPS Agreement. The measures relate to legislation on plant variety protection, amendments to the existing Indian Patent Act (1970), and control over and protection of biodiversity.

Since the past few years, the ICAR has initiated several measures and included the protection and licensing of intellectual properties (IPs) as a priority item on its agenda. It is trying to build a sound system to protect and license the IPs to better serve the Indian society and support its programs. As a step in this direction, ICAR has set up a new unit at its headquarters in New Delhi exclusively for dealing with issues relating to IPR. The IPR-Unit of the ICAR became functional on October 13, 1998. Since then a number of steps have been initiated (Mishra 1999).

1. Technical staff has been provided to the new IPR Unit. Consequently, the IPR Unit has evolved suitable formats for disclosing inventions and compiling invention details (complete specifications) by the scientists of ICAR.
2. A number of circulars and letters have been issued to the directors of ICAR institutes, describing the procedure for compiling applications, filing the same with the Patent Branch Office at New Delhi.
3. The IPR Unit has also issued guidelines to ICAR institutes for protection of Indian genetic resources from bio-piracy.
4. To keep updated on the developments in biotechnology and to assess the preparedness of the ICAR, the IPR Unit has compiled a compendium of Indian scientists engaged in DNA fingerprinting, for increasing awareness among scientists and for capacity building at ICAR institutes.
5. The IPR Unit has also begun organizing workshops to increase the awareness about IPR issues among agricultural researchers and administrators.

As a result of the above steps and initiatives of the IPR Unit, applications for patents have started flowing in at the ICAR Headquarters. The IPR Unit has begun filing these patent applications. However, more needs to be done in the IPR area and the IPR Unit has started identifying its needs and strategies for evolving a comprehensive IP management system/program at ICAR.

In addition to giving support to 59 public agricultural research institutes, bureax and centers that operate under ICAR, the IPR Unit has to also meet the IPR needs of 29 State Agricultural Universities (SAUs). The IPR unit has initiated work in this direction by identifying nodal officers at various institutes of ICAR.

These nodal officers will become crucial links between the IPR Unit at the ICAR Headquarters and the institutes of ICAR in regard to IP management. The IPR Unit will evolve programs for development of nodal officers at the institutes and universities concerned. The IPR unit of ICAR expects to receive a large number of applications for patents and the staff's workload will increase tremendously. Because of this the IPR Unit at ICAR is in the process of developing a strategy to strengthen the public research system through staff training both within the national system and abroad.

Indonesia: IP and Technology Transfer Office at AARD[7]

The organizational framework developed in Indonesia to deal with the issues of IPR presents an interesting case of institutional innovation designed to exploit the private good nature of intellectual properties, and at the same time address the needs of public agricultural research system. The Agency for Agricultural Research and Development (AARD) is part of the Ministry of Agriculture and forms the main body of the national agricultural research system of Indonesia. In July 1999, the AARD established the intellectual property and technology transfer office known as the *Kekayaan Intelektual dan Alih Teknologi* (KIAT). The office is part of the Indonesian Agricultural Research Foundation, an independent non-profit organization established by the government of Indonesia to attract funds from the private sector and to facilitate technology transfer, licensing and commercialization of agricultural technologies developed through conventional and biotechnology methods.[8]

KIAT serves as a main focal point for IPR within AARD and is responsible for serving 10 agricultural research centers and 17 regional assessment institutes in the matters of agricultural technology transfer and protection. Within two months of its establishment, KIAT started negotiating five license agreements to commercialize a wide range of agricultural technologies (biofertilizer, hybrid maize and animal vaccine). It has already started licensing research products of AARD (e.g. Rhizobium based biofertilizer for soybean) to the private sector, which is generating revenues for KIAT. It has also licensed a series of hybrid maize to a leading seed company owned by the government of Indonesia.

One of the challenges facing KIAT is to familiarize AARD researchers with IPR concepts. KIAT is expected to play a key role in educating AARD researchers and administrators on various aspects of IP and technology transfer. The KIAT office will also play an active part in facilitating the establishment of spin-off companies based on technologies generated from AARD. It is hoped that KIAT

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[7] The description of activities in Indonesia is from Maredia, Erbisch and Sampaio (2000).

[8] The Director General of the AARD serves as the member of the Board of Trusties of this foundation. Being private and non-profit organization, the foundation can act freely in dealing and doing business with the private sector. Funds received by the foundation do not merge with the government treasury and are used to pay the operational costs, make royalty payments to public sector researchers, fund research programs, and pay the cost for IP protection.

will be the focal point for IP and technology transfer for AARD and in "brokering" to get the necessary technology from abroad, especially biotechnology.

Egypt: IPR Capacity Building at AGERI[9]

In Egypt, the Agricultural Genetic Engineering Research Institute (AGERI) is the main focal point for biotechnology research. AGERI is a part of the Agricultural Research Center (ARC) in the Ministry of Agriculture. It actively works with other universities in Egypt and is recognized as a center of excellence in agricultural biotechnology research in Egypt and in the Middle East. To help address the IP management issues, AGERI has recently established an Intellectual Property and Technology Transfer Office. Based in AGERI, this office will serve the scientific community in AGERI and other institutions in ARC.

The office currently has a technology transfer coordinator and an administrative support staff. The office, though in its infancy, has made significant progress in IP policy and management. It has developed an IP policy for AGERI. The office is also very active in creating awareness and education of ARC scientists in various aspects of intellectual property protection and IP management as they relate to agriculture. The office will also play a key role in the development of MTAs, and licensing of technologies generated in AGERI and ARC. The office is also developing educational materials on intellectual property management for scientists (in Arabic and English). The IP office at AGERI will serve as a liaison with the private and public sector in Egypt and abroad.

Summary

From the summary given in Table 2 and the case examples of institute-level capacity building in agricultural research systems of developing countries, at least two clear points are emerging about the status of IPR in developing countries as it relates to agriculture. First, slowly but surely, developing countries are adopting new laws or modifying existing legislation to comply with the standards stipulated in international treaties. The progress in implementing PVP laws is more evident than in the expansion of patent protection. Second, effort to develop institutional capacity in public agricultural research systems to deal with IPR issues is progressing hand-in-hand with the national level efforts to implement new IPR policies. Even though developing country National Agricultural Research Systems (NARS) are at different levels of IPR capacity building and are adopting different models of organizational structures, they all seem to be facing common challenges in terms of human resource development and educating the research community on IPR concepts and issues.

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[9] Based on K. M. Maredia (personal communication, 2000)

Expanding IPR in Developing Countries: Issues, Challenges and Options

By setting minimum global standards for IPR, the TRIPS Agreement effectively removes from developing countries the ability to choose systems in much of the lower ranges of the protective scale. Existing theoretical treatments strongly assume that the Agreement will engineer a full equalization of standards at levels of the industrialized countries (Helpman 1993). The preliminary survey results presented above, however, indicate that the implementation status and type of protection options opted by developing countries are far from the levels of some industrialized countries. Developing countries are certainly not inclined to adopt patent protection regimes for plant varieties such as the one that exists in the United States. Nor in many cases are they prepared to grant patents for plants (as opposed to plant varieties) in a system akin to the one that exists in Europe. All the countries surveyed were rather inclined to adopt a *sui-generis* legislation (plant breeders rights) (Table 2). Furthermore, most of the developing countries, that have so far become members of the UPOV Convention, have not yet adjusted fully to the standards of the PBR at the level of the 1991 Act.

Expanding IPRs to agriculture is still a major concern for policy makers and a constant topic of discussion and debate among the civil society (see Box 3). There is considerable speculation on the impact that expansion in IPRs will have on R&D, technology transfer, and economic development in developing countries (see Annex 2). In this paper our focus is on some of the highly debated issues of particular concern to agricultural research. In the following two sections, we present a conceptual analysis of the issues, challenges and options faced by developing countries in expanding their IPR framework at two levels of implementation – at the national policy level and the public research institute level.

At the national level (i.e. various ministerial levels), policy makers have to make decisions based on the objective of achieving national developmental goals (poverty alleviation, food security, expanding agricultural exports, etc.). In designing an IPR policy, they have to comply with the minimum global standards of IPR as laid down in the TRIPS Agreement (if they are members of WTO), while simultaneously safeguarding the interests of farmers and local entrepreneurs. Their decision framework encompasses all sectors of research – public and private, national and international. The goal is to make the best agricultural technologies available to local producers – whether it comes from the private sector or the public sector. Not providing protection to technologies and innovations defined in the TRIPS Agreement is not an option for policy makers of member countries.

For a public research institute, on the other hand, not seeking protection of their innovations is still an option. The decision-making framework of a public research institute is governed by the objective of maximizing the public good within the national IPR policy framework. The issues, challenges and options facing a public research institute are therefore different from a public policy maker. Public researchers' and managers' decisions about IPR will be innovation-specific and governed by the relationship they envisage with other public and private research institutes in the development, commercialization and dissemination of that innovation.

In what follows, we discuss the issues, challenges and options facing developing country agriculture sector, first at the policy level and then at the public research institute level (encompassing research programs and projects). At the institute-level, the objective is to present a conceptual framework of management decision making based on economic principles. The discussion is focused on the protection of plants; issues, challenges and options with respect to animals (livestock and fisheries) may be similar.

4. Expanding IPR to Agriculture: A Conceptual Analysis of Policy Decisions

4.1 Why IPR is a Concern for Research Policy Makers?

It has been argued that IPR for plant material may have an adverse impact on plant breeding and farming practices in developing countries, both of which have been well-served by public research in the past. IPP of plants would, among other things, a) restrict the exchange of germplasm and b) restrict on-farm seed saving (e.g., Fowler et al. 1988, Dias 1988, ICDA 1989, DGIS 1991, Keystone Center 1991).

Consequences for the exchange of plant germplasm

One concern about expanding IPRs in agriculture is their effects on the flow of breeding materials. The free international exchange of improved varieties and parental material (which made the Green Revolution possible) may become restricted when plants become protected under patent law or a *sui generis* system. Falcon (2000) raises concerns about the changing institutional circumstances related to IPRs and its impact on technology transfer. According to his assessment, the probability that the sequence of events that led to the Green Revolution (e.g., widespread distribution by CIMMYT of sample wheat seeds containing the dwarfing gene, Norin 10 and the subsequent manipulation by several breeders around the world to develop high yielding semi-dwarf wheat varieties) would occur under the current regime of strengthened IPR is quite low. On the positive side, the IPR framework may increase the flow of germplasm and varieties through the private sector because companies may have more incentives to bring elite germplasm into developing countries.

Proprietary technologies are increasingly incorporated in the germplasm or products developed by the publicly-funded institutions such as those supported internationally by the Consultative Group on International Agricultural Research (CGIAR) (Cohen, Falconi and Komen 1998). The seed industry itself is concerned about the reduced flow of germplasm as a result of patenting as opposed to PBR for plants and recognizes the need to ensure that this flow is maintained (FAO 1998).

The respondents of the survey conducted by the author also indicated their concerns about the negative effects of expanding IPR. To the question asked in the survey on “How will the global trend in the use of IPR protection affect the accessibility and transferability of research inputs and outputs from/to international public research community?” an overwhelming 56% of the 27 respondents replied that it will affect negatively, 30% indicated that it will affect positively, and the remaining 11% said it will not affect at all.

Under patent law all unauthorized commercial use of patented matter is prohibited. With respect to plants, this means that the use of patented plant material in breeding programs may be refused or restricted by the patent holder. If authorized, the royalties that presumably must be paid will raise the costs of the research program. Eventually, the seeds of plants covered by a patent will be more expensive than other seeds available in developing countries, but then, of course, will not contain the advantages of the patented invention. Biotechnology patents might severely restrict worldwide germplasm exchange in case a patent is granted whose claims cover a widely used plant trait

Like patented plants, the exploitation by breeding institutes of plant varieties that are protected under PBR that conform to UPOV 1991, requires authorization and the payment of royalties in the rare event that the new bred variety is considered to be essentially derived from the initial variety.

This issue is closely linked with measures to control access to plant genetic materials as envisaged in the UN Convention on Biological Diversity (CBD). It is also linked to concerns that biodiversity be maintained since it is the source of future breeding genetic resources. Different traditional and communal systems should have control over the access of this material and receive benefits from its use in products that are subsequently marketed.

Consequences for on-farm seed saving

Saving seed for the next crop cycle is a basic farmer practice in developing countries. At the beginning of the 1980s an estimated 80% of total seed requirements in all developing countries were met by saved seed (Groosman 1991). However, seed saving practices might become severely restricted if developing countries begin to recognize patents on plant material. Saving seed could also become restricted if the State does not introduce farmers' exemption to save seed on the farm.[10]

Seed saving of patented plants involves the duplication of patented matter. If not for private non-commercial use, unauthorized saving of seeds covered by a patent is an infringement. The use of patented plants consequently raises the overall agricultural input costs and makes farmers more dependent on external seed producers. Farmers are either obliged to ask for authorization of their seed saving practices, which will entail the payment of royalties, or they are obliged to buy seeds for every new crop.

During the negotiations on the revision of the 1978 UPOV Act, the farmers' privilege was intensely debated. There was consensus that agricultural conditions varied so widely from State to State that the authorization of the on-farm seed saving of PBR protected varieties should be left to national authorities. The allowance of on-farm seed saving under UPOV 1991 may therefore vary across its member countries although no UPOV Member State that has adhered to the 1991 act has eliminated the farmer's privilege. If not allowed, the farmers face the same restrictions as with patented products.

4.2 Challenges for Policy Makers

In a world where so many industrial country firms are acquiring strong intellectual property rights, often covering fundamental research tools (e.g., tools used for genetic transformation) and marketable products, it is becoming difficult for developing countries to play isolationist and ignore IPR policies. Given the concerns highlighted in the previous sections, the challenge for policy makers in developing countries is to strike a balance between their need to access modern agricultural technologies and developed countries' need to access the markets and biodiversity. Policy makers in developing countries need to also ensure that the R&D sector serves the agricultural sector well and to safeguard the interests of farmers, a majority of whom still follow traditional practices of farming. Some of the challenges facing policy makers in developing their IPR system as it relates to agriculture are discussed below.

Scope of protection

Policy makers face the difficult task of defining the scope and breadth of protection (within the minimum standards framework defined by WTO) so as to maximize social welfare and to achieve certain distributional objectives. Too weak protection may lead firms to invest less than socially desirable in the

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[10] It should be noted that the 1991 Act of the UPOV Convention allows member states to decide whether or not to introduce the notion of farmers' privilege in their PBR legislation. In fact, many member states of the 1991 Act have decided to introduce farmers' exemption.

creation of new knowledge. Overly stringent protection may lead to wasteful research spending as firms compete to be first to innovate, which may make public research more socially desirable than private R&D. Only rarely will a single level of protection for all technologies or sectors maximize domestic welfare as the trade-off between the economic benefits of innovation and imitation will depend upon the sector involved.

Thus, in discussing about IPRs, it is useful to categorize the crop sector into three groups: (1) open- or self-pollinated cereals and vegetatively propagated tubers, (2) inbred lines and horticultural crops, and (3) other economically important plants (e.g. medicinal plants). For each group specific characteristics have to be taken into account with regards to the application of IPRs.

Cereals and tubers that consist staple crops in many countries pose the most complicated challenges for policy makers. Millions of farmers re-use the grains or tubers that they harvest for next season's production. Moreover, within the context of informal seed systems in which farmers freely exchange, trade and save seeds, landraces and indigenous knowledge often contribute to the adaptation of varieties to specific farming systems. The challenge for policy makers is to ensure the “farmers’ privilege” in continuing use of their traditional practices, while simultaneously developing a protection system that compensates the plant breeder and technology innovators.

Horticultural crops, such as ornamentals, fruits, vegetables and plantation crops are not covered by the farmer’s privilege in many countries. In the case of hybrid varieties of some vegetable species, the botanical features of the protected material make its reuse unattractive for farmers. The harvested product generally cannot be used as propagating material for the next generation as it is the case with grains from cereals. Parental lines for the production of hybrid seeds, inbred lines, are normally kept by the breeders. They are of no interest for farmers/consumers because of their low yield and quality, but can be of interest to competing breeders. In the case of those horticultural crops that are vegetatively propagated, harvested materials can be easily used for next season’s planting. For these crops the extension of the protection to the harvested products is important. The challenge for policy makers is to develop an IP system that sufficiently safeguards breeders inventions against plagiarism without giving them a monopoly power.

The property status of medicinal plants is the subject of a political debate. It is felt to be an injustice that the characteristics of these valuable plants can be protected by patent, because they are considered as a heritage of humanity and should not be monopolized by a few. The challenge for policy makers is to ensure that these valuable plants remain in the public domain.

IPRs, biotechnology and market structure

Overall, the economic effects from stronger IPRs are far from simple, clear or agreed. However, companies will not use genetic engineering to modify plants and animals unless they can recoup their investment in research and product development. IPRs were developed for manufactured goods, where companies can expect repeat business as fashions change or items wear out. New varieties and many biotech goods, however, are living organisms which can reproduce themselves and so may not require repeat purchases. To ensure a return on investment and a future income stream from these innovations, companies want IPRs, especially patents to cover not only the original material but also new plant varieties developed by using such material.

An alternative for some crops may be to breed varieties that will not reproduce. Biotechnology-based switch mechanisms to restrict the unauthorized use of genetic material have been described in a number of patent applications. These have been grouped under the collective term, Genetic Use Restriction Technologies (GURTs). One such patented restrictive use technology (granted to the USDA and American Delta and Pine Land Company) modifies plants in order to prevent seeds from germinating in the next generation. Seeds incorporating this technology would not require legal agreements or enforcement officers to stop farmers reusing them. However, this type of technology has raised many controversies in developing countries and has created emotional outbursts against modern biotechnology and multi-national corporations (Lehmann 1998).[11]

The challenge, therefore, for developing country policy makers is to have an IPR system comprehensive enough to cover technologies of modern biotechnology, yet ensuring a fair competition so that one or a few corporations do not control the vital inputs of agriculture.

Recognizing farmers' rights

There is a clear and explicit recognition by the international community of the critical role of farmers and indigenous peoples in preserving biodiversity, conserving, improving, and making available plant genetic resources, and in developing and providing knowledge of the value of plants and forest resources for food and medicines.

The FAO, in its Resolution 4/89 accepts that PBR are not incompatible with the International undertaking but also recognizes the rights of farmers as arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources particularly those in the centers of origin or diversity. Article 16(2) of the CBD obliges countries to ensure

[11] The FAO recently commissioned a study on the GURTs technologies (FAO 2001). This report provides a good discussion of the potential economic impacts of GURTs technology on agricultural biodiversity and production systems.

that any IPRs under national or international law are supportive of and do not undermine the Convention.

Complying with various international treaties

Developing countries are under pressures of not only the TRIPS Agreement but also other international treaties and conventions such as CBD, which have conflicting requirements in terms of protecting a country's natural resources and intellectual property. The laws and regulations for intellectual property protection in developing countries have to meet the international standards and practices specified in the TRIPS Agreement and, the CBD (if they are members of both treaties). If they chose to join UPOV they will also be bound to accept the requirements of the UPOV Convention.

4.3 IPR Policy Options

Costs and benefits of Implementing IPR policies

To address the challenges of developing an IP system will require a careful analysis of the costs (including opportunity costs) and benefits to the society of expanding IPRs. Determining the benefits and costs related to changes catalyzed by new IPR regimes is however, a complex economic problem. In theory, IPRs should stimulate innovation and economic growth by mobilizing private sector investments in local agricultural research and development (see discussion in Annex 2). One way in which IPRs stimulate innovation is by making the new knowledge accessible to public. For example, patents make information about the invention public instead of keeping it as a trade sectet. In the absence of an effective IPR system, research firms would keep a considerable amount of information about plant genomes and the function of genes secret, thus restricting its use in further knowledge creation and technology innovation.

PVP, for example, can stimulate foreign breeders in making available their modern varieties. It can create an incentive for breeders from industrialized countries to export their best and most recent varieties to countries in which an effective PVP system has been implemented. This kind of technology transfer, facilitated by IPP, was one of the motives for the introduction of PBR in New Zealand, in 1973. In 1990, over 60% of the applications for protection were for foreign bred varieties. In the period from 1975 to 1987 several North American varieties of apples, peaches and nectarines as well as an East German barley variety were made readily available to New Zealand's growers. It is significant that this was not the case for growers in Australia where PBR protection was not available at that time.

There are indications that experiences of Argentina and Chile have been more or less similar to those in New Zealand. In Chile, it is believed that PBRs have

resulted in greater access to the latest fruit technology from California. The authorities are planning to extend PBR to forage crops so that they can get better and improved varieties from other countries. However, it is important to note that the response from foreign breeders to enter the seed market in a given country does not depend only on the existence of PBR. The market must also be intrinsically interesting for crops bred in the private sector.
Rapid access to the latest varieties and unimpeded exports may be especially important in specific agricultural sectors in some developing countries that depend on exports to OECD countries, such as cutflower production in Colombia and Kenya. It is within these sectors, that the benefits of IPP may outweigh the limitations that IPP system imposes.

However, IPRs may have social costs if the granting of temporary monopolies, lead to excessive rent seeking by firms. (Table 3). . To minimize these social costs, governments will need to ensure competition from both private and public sector. The public sector may have to play an important role in continuing research in traditional crops and technologies and strengthening capacity in modern biotechnology research.

Legislation without implementation is of little value; and implementing the IPR system involves a number of administrative and institutional costs to the society (Table 3). These include the costs involved in developing the appropriate laws and enforcement mechanisms within each country. Patent examiners need special training to deal with biotechnological applications or countries need to hire new examiners with degrees in biology and biotechnology. For PVP, an appropriate administrative system must be established. WIPO and UPOV operate training schemes for developing countries and provide assistance to those seeking to implement the TRIPS Agreement. Empirical evidence suggests that these direct costs to the society could be particularly large in a developing country (Table 3).

However, these administrative costs may only be partially borne by governments. Patent and trademark offices can be self-financing operations through the levies from application and renewal fees. A careful balance has to be struck, however, between generating revenues for the administrative office and keeping fees sufficiently low so as not to exclude small-scale inventors from the IPR system. An alternative to reduce administrative costs is to contract researchers at universities and other institutions to provide technical reports (the cost of which should be borne by the applicants). Another alternative is to provide for a “deferred system” (which exists in many countries), whereby a special request for examination needs to be made by the applicant during a certain period (UNCTAD 1996). The rationale for this system is that some inventors may decide to abandon the application, thus reducing the number of applications to be examined by the patent office. Yet another option for keeping the costs of running the patent system down, as is the case in South Africa, is to not require any patent examinations and let the patent holders defend their patents in court.

Administrative costs are likely to increase with the implementation of the IPR framework. But these should be viewed in light of the costs of alternatives. Thus, an important question that policy makers need to address is whether the costs of setting up a patent or a PVP system are large relative to the cost of strengthening public sector research and development in agriculture? Intellectual property protection provides greater benefits than costs in the advancement of science, technology, and economic performance. However, the benefits of intellectual property protection often accrue in the future, thereby making the near-term costs seem large. The protection benefits both private and the public sectors and it is the allocation of the return, which is determined by public policy.

Yet another factor that policy makers need to consider in establishing an IP system is the cost of protection to the innovators as well. The standard system of patenting would be inaccessible for many small entrepreneurs and grassroots innovators due to limited resources and their risk-averse nature. National governments may have to think about establishing innovative low cost system like *Petty Patents* that can ensure protection for shorter time at lower cost (Gupta 1999).[12] Petty patent will help small entrepreneurs to explore the commercial application of their invention in a given (shorter) time. Later they can choose to go for regular patent or else their petty patent expires and their invention becomes part of regular “prior art.”

Policy Implications and Options

The combination of the specific impact of IPP, the need to acquire advanced technologies and foreign trade pressure make the adaptation of national IPP regulations much less maneuverable than the word “option” may suggest. Nevertheless, some flexibility remains under the new international IPP scenario, and there are options for additional policies that also influence the availability of agricultural technologies. In principle, there are four general sets of options for policy related to IPP in developing countries.

1. <u>Form alliance with contesting forces</u>

Under the TRIPS Agreement, developing countries may exclude plants (and animals) from patent protection; plant material would consequently fall outside the patent system. Patenting living material is still heavily contested within OECD

[12] Gupta (1999) discusses the concept of a Petty Patent based on Australian experience with their “innovation system.” Under a petty system, he recommends a term of at least 10 years for 5-7 claims, lower inventive threshold, and availability of a product and use patent. Thus an indigenous herbal drug developed by a local healer, for example, can receive product patent (under the petty patent system) for 10 years. During this period, potential manufacturers may get in touch with the inventor and may negotiate the right so as to file a standard patent if large scale manufacture was considered desirable and profitable. The fees should be negligible but publication of application within a year should be obligatory and the granting of patent should not take more than a year or 18 months.

countries, notably in Europe. Forming alliances with contesting forces in OECD countries may therefore be a useful strategy for developing countries.

Another way of contesting some of the restrictive terms of the TRIPS Agreement is to use the Biological Diversity Convention (CBD). This convention basically comprises a deal between developing and industrialized countries: the developing countries co-operate in the conservation of biological diversity in exchange for a share in the benefits arising from the exploitation of genetic resources which are collected in their countries. This share may consist of financial returns and of access to relevant technologies. It is the latter formulation that is particularly appropriate for the mitigation of restrictions ensuing from a biotechnology patent.

Particularly, those developing countries that have a rich diversity of plant genetic resources may profit from this Convention. For example, they may be granted a (priority) right to use patented plants or biotechnology on preferential terms. The Convention might also be used to make compulsory licensing less restricted in contrast to what has been provided for under the TRIPS Agreement.

However, it should be noted that the wording of the Biodiversity Convention is itself ambiguous. Interpretation of several Articles is apt to give rise to disagreement. The convention, for example, stipulates that access and transfer of technology shall be provided on terms that recognize and are consistent with the adequate effective protection of intellectual property rights. It is not clear how that relates to the provisions of the Convention's Article 16, which obliges countries to ensure that any IPRs under national or international law are supportive of and do not undermine the Convention. Furthermore, the Convention has not been signed by all industrialized countries, especially by the USA, thus undermining its effectiveness as a contesting force.

<u>2. Exploit loopholes and ambiguities</u>

Another set of options refers to policies that do not run counter to the international IPP standard, but exploit existent loopholes and ambiguities in the text of the TRIPS Agreement. These policies may have the effect that the impact of high level IPP is less stringent or that its implementation is delayed.

Exploiting loopholes and ambiguities in international IPP agreements may be a viable strategy for most developing countries. For example, no definition is provided in the agreement for the criteria for patentability (novelty, nonobviousness, and industrial applicability). These would be subject to interpretation by national patent offices in each developing country.

Another area of the TRIPS Agreement that is especially ambiguous and provides room for exploitation and interpretation to the advantage of developing countries is the *sui generis* system. The International Plant Genetic Resources Institute (IPGRI) has produced a checklist for use in developing a *sui generis* system

(Leskien and Flitner 1997). They suggest it may be worthwhile for countries to explore how options can be mixed and matched, including the prohibition of double protection and providing different levels of protection for varieties of the same species depending upon their intended use. Defining an appropriate *sui generis* system will depend upon: the type of domestic seed industry that exists, the level of use of farm saved seed, the current capacity of breeders, local (national) breeders' aims in the next 5-10 years, the country's biotechnology capacity, the goals and realistic expectation of the biotechnology sector, and the types of strategic alliances likely to be entered into.

In developing countries, it seems appropriate to have a *sui generis* system which allows for free seed saving and flow of seeds between farmers for food crops. For instance, national PVP legislation could include a provision for the compulsory licensing of varieties of open pollinated food crops.[13] This would provide a right (authorized by national authorities) to any interested party to save and trade the seed of protected varieties, with or without the obligation to pay a royalty. Another possibility would be to extend the farmers' privilege to seed exchange and small, non-commercial seed trade.

However, to offer an effective *sui generis* system, care must also be taken for the remuneration of the breeder. This could be done by means of a public or private central fund from which the breeder gets paid on the basis of the acreage of the breeder's protected variety that is grown by the farmers. The endowment for the fund could be raised by the government, the farmers or both, depending on the national situation.[14]

3. <u>Adopt additional policies to mitigate adverse impacts</u>

The final set of options comprises policies which may mitigate adverse impacts of the new international IPP standard and which are often beyond the scope of IPP legislation. The key challenge is finding a way to reverse the oligopoly while maintaining the use of IP incentives to encourage research. Barton et al. (1999) discuss several options and mechanisms to prevent oligopoly and monopolist effects of IPRs. These include:

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[13] Compulsory licensing provisions offer nations grounds for response should an IP holder misuse its IP powers or should there be inadequate competition. Examples of developing countries that have provided compulsory licensing of crop varieties are rare to find. Barton et al. (1999) note that compulsory licenses for use of other types of IP such as patents are also granted infrequently. This may be because of administrative complexity or it may be because the threat of compulsory licensing creates a more favorable climate for agreed licensing.

[14] However, the issue of remuneration also raises other issues and challenges. For example, creating incentives for scientists working on non-monetary technologies such as agronomic or cultural practices to control pests and diseases that may be as important as new varieties. How to balance reward for scientist who develop technologies that can be covered under IPR and who develop technologies that have no potential commercial application, will remain a challenge for policy makers.

- Strengthening appropriate competition laws. Barton et al. (1999) discuss three types of policy responses in this area. One is to protect prices or competition in domestic markets by imposing reasonable price controls, for e.g., on seeds. However, there may be good policy reasons against such an approach. For example, administrative costs may be substantial, or it may deter a firm from bringing new and advanced seeds into domestic markets or from investing in research to develop new products specifically for domestic markets. A second approach is to apply competition law principles to the situations in which a global firm interacts with a local company. Thus, in deciding whether or not to approve a multinational's purchase of a local firm, they should examine the likely competitive situation in their nation with and without the acquisition. If there are enough competitors already present and if the local entity can obtain much better access to global technology as a result of a merger, it should normally be approved. Otherwise, the merger should not be permitted. A third approach is to give local firms a right to a compulsory license of technology from the multinational under appropriate market conditions. However, Barton et al. (1999) caution that this approach should only be used if a local firm has developed significant technology, and is unsuccessful in negotiating a cross-license with the multinationals on terms similar to those on which the multinationals are licensing each other.

- Tougher application of the traditional patent principles of novelty, non-obviousness (or inventive step in the law of many nations), utility, and enablement (i.e., an adequate explanation of how to practice the technology across the full scope of the patent's claims). TRIPS agreement requires that each nation's standards in these areas be reasonable, but does not require that they be the same as those currently in use in specific industrialized nations. Thus, a developing nation may reasonably use higher non-obviousness standards than, say the U.S. Patent office, and thus grant somewhat fewer or somewhat narrow patents than are granted in the U.S.

- Tougher application of the statutory research or experimental use exemption, so that patents cannot be used to bar research. This approach speeds the development of science and improves the bargaining position of developing-nation research institutions. For a more scientifically advanced developing nation, it might be wisest to take a carefully balanced position of allowing a compulsory license for research use. This would permit use of the invention as a scientific tool even when the invention is not marketed, but would require payment of an appropriate royalty. Nations with a significantly smaller market and scientific capability might reasonably simply permit free use in research. The aim of these measures should be to make it impossible for IP holding firms to block off an area of research. And they would also strengthen the position of local researchers who are working to develop new technologies, using tools that have been patented by others.

- Limiting the scope of patent claims and broadening the responsibilities of patent holders. This can be done for example, by: a) Shifting the burden of proof in the 'enablement entitlement' in patent law such that patent holders have to prove that wide-ranging claims will work rather than the challengers that they will not; b) Limiting or prohibiting the use of functional claims; and c) Ensuring that mechanisms are in place to balance the claims of initial and subsequent innovators.

- Allowing for compulsory licensing of biological and biotechnology inventions. Article 31 of the TRIPS agreement allows for certain uses of a patented invention without the authorization of the right holder. This provision covers both compulsory licenses and government use. Compulsory licenses permit the government to grant a use license to third parties without the permission of the patent owner, subject to equitable payments and specific circumstances. Use by government without the authorization of the right holder and in the public interest is also allowed. There is no restriction under TRIPS agreement on the grounds on which such use can take place and thus WTO members are free to set forth the grounds in their national patent laws. There is also the possibility of patent revocation on grounds of abuse, exemplified by failiure to work. But according to Article 5A of the Paris Convention, this cannot take place until two years from the date of the first compulsory license.

5. Management of IP in Agriculture: A Conceptual Analysis of Issues and Options for Public Research Institutes

In the previous section, we discussed the issues and concerns of national governments at the macro-policy level. The questions facing a policy-maker are concerned with developing appropriate IPR laws and legislation, and providing a legal framework by defining “the rules of the game”. At the public institute level, the decisions facing a researcher or a manager are whether and how to “play the game.” With the global trend of increasing contribution of the private sector in R&D, increasing application of modern biotechnology, and the protection of intellectual property rights in agriculture, not only are the rules of the game changing rapidly but also the role of the public sector and its relationship with private sector is changing. In this changing world of agricultural research, agricultural scientists and research managers in public institutes are facing complex questions and micro-level management decisions about the use of IP owned by others and the protection of their own plant and animal technologies.

Intellectual property is a novel concept for many developing countries, and especially so for public research institutes. But in a world where more and more private sector firms in industrialized countries are acquiring strong intellectual property rights, it is proving difficult for public research institutes in developing countries to elbow into this new global industry without taking up the challenges of IPR. Public research institutes need to be able to negotiate agreements to use these technologies, acquire human and financial resources to manage their own IP, and participate in the continuing debate about particular forms of IP to ensure that their interests and those of their clients are taken into account (World Bank 1999).

The application of IPRs in a public research institute poses complex issues and challenges on both sides of management decisions -- the **protection** of their own plant and animal technologies and the **use** of IP owned by others. If protection is to be introduced, they want to know:

- Which type of IP protection will most directly address the perceived needs of public research?
- What types of IPP are relevant for agricultural research?
- How to estimate the market value of patents, plant variety protection and other intellectual property for new and potential products so as to make IPR decisions cost-effective?
- What are the likely benefits and costs of that protection versus those from leaving research results unprotected?
- How can public research organizations ensure that their inventions become available for use by the society?
- Would there be any significant gains from using IPR protection as a strategy for generating new revenues for research?

In making decisions about the use of protected IPs of other national or international research firms the issues that often arise are:

- Whether to license the use of a protected technology or invent around?
- What terms and conditions to negotiate with research firms to ensure their freedom to operate?
- How to strike a favorable agreement?
- How to experiment and use products without indulging in the illegal use of other's IP?

In this section, we discuss the issues concerning both these aspects of micro-level decision making by a public research institute. The aim is to provide a conceptual framework within which to analyze the decision options available to a public research institute.

5.1 Issues Pertaining to Protection of Intellectual Property Rights

Rhetorical issue: should a public research institute protect its intellectual property?

One of the missions of public research institutes is to generate knowledge, technologies, and products that promote the "public good." Traditionally, this has been achieved by practicing the “open science” policy, which means that researchers and scientists at public institutes completely disclosed all their discoveries and innovations to the scientific community and made it available for commercialization at no cost (i.e., zero technology fee or licensing fee). In developing countries, many of the products and technologies were (and are still) disseminated to farmers through public sector extension service. The mission and strategy of a public research and extension service are in sharp contrast with that of a private firm, which seeks to gain a competitive advantage over rivals by keeping its discovery secret.

The option of protecting one’s innovations, especially plant varieties and animal technologies seems at odds with the mission of public research. It is raising concerns and criticisms not only in developing countries but also in industrialized countries (Maredia et al. 1999). Thus, one of the questions facing public institute managers and researchers is whether they should protect their intellectual property? Surely, there is no one prescriptive answer to this question. The critical economic condition that can help answer this rhetorical question is whether in the absence of protection there will be a significant loss in the social value of current or future innovations (i.e., whether the loss exceeds the cost of protection).

One of the instances where protection makes economic and social sense is when the protection of intellectual property helps promote public-private cooperative relationships and speeds the development of new products and services based on publicly funded research. The benefits to society are in the form of minimizing social costs of research investments. If a public research institute generates a technology or a product with great potential social benefits but requires huge financial resources or business structure to further develop and market these major scientific breakthroughs, then the public’s interests are best served by protecting and restricting its use. This is necessary to give protection to the private sector, which will be the vehicle through which the technology will be made available for public consumption. Given the costs involved in commercializing a technology, no private enterprise will use research results without being given the legal protection by a public research institute in the form of an exclusive or non-exclusive licensing agreement. Thus, by protecting the IP, a public institute decreases the social costs of research investments in the form of social gains foregone if an innovation were to remain undeveloped or not commercialized.

Public institution may have to opt for protection for defensive reasons too. In order to exhaust claims for protection by other parties, an invention has to be published completely which is not always easier. Scientific publications take long time to publish and by that time a third party may claim rights over such findings. Unless a registry to disclose findings of research at low cost and timely fashion is made available in developing countries, opting for protection may be a better defensive strategy for creating greater public goods.

Thus on rhetorical grounds, there is enough economic and social justification for a public research institute to protect its intellectual property. This has been the practice of public institutes in non-agricultural fields of research in industrialized countries and even in some developing countries. In fact, protecting the intellectual property, especially plant varieties, is also becoming a trend and practice among public agricultural research institutes. Since the PVP Act became operational in China two years ago, public breeding institutes have filed 66 applications for plant variety protection; none so far have been filed from the private sector (Shumin and Lijun 2000). In Korea, a total of 248 applications for PVP have been filed by the public research institutes and 48 by the private sector (Keun-Jin and Hae-Yeong 2000).

With the advent of biotechnology, agriculture is becoming more and more industrialized and public agricultural research institutes are compelled to work collaboratively with the private industry. Farmers/producers in developing countries are increasingly demanding technologies that can help them increase their productivity and profitability. With the changing “rules of the game,” it thus makes both economic and social sense for a public agricultural research institute to protect their plant and animal technologies. This is being recognized increasingly by public sector researchers in developing countries. In the e-mail survey, none of the 27 respondents chose the option of “not seeking IP protection at all” as a strategy for public research. Thus, although the extension of IPR may seem to be in conflict with the traditional role of public research to create, sustain and disseminate knowledge as a public good, it is increasingly perceived as a strategy to address the perceived needs of public research (Maredia et al. 1999).

However, agricultural research programs are not at the same level of advancement in all sectors of research across all developing countries. Some countries are well advanced in building research capacity in biotechnology and allied technologies (e.g., Brazil, Egypt, India, Indonesia, Mexico, and Philippines) and are experiencing a rapid change in the “rules of the game”. However, most countries of the developing world have little research capacity in biotechnology, and agricultural research is still focused on developing conventional technologies. The need and urgency to protect agricultural innovations, therefore, may not be felt uniformly across all developing countries and sectors of research.

Research managers need to make decisions on whether or not to seek protection for a given technology and research product on a case-by-case basis. Not seeking protection of a particular technology (when it is available) still remains one of the options that a public research institute should be opting for on economic and social grounds.

Management and decision issue: should a public research institute protect technology XYZ or leave it in the public domain?

The critical decision question that a researcher and/or a public research manager faces is whether or not to protect a particular technology or product at hand. The answer will depend on the assessment of the likely benefits and costs of seeking protection versus those from leaving research results unprotected. If no form of protection is taken, then research results are generally placed in the public domain, mostly in the form of publications, blueprints, and finished or un-finished products, making them available to all without restrictions on use.

Many factors determine the decision about whether or not to protect a particular technology developed by a public research institute. Figure 1 lists some of these factors and speculates on how they may affect the decision of a public institute about seeking protection. Some of these are standard economic variables and are the same as those taken into consideration by a private firm. These include the cost and monetary benefits of protection. These are influenced by the potential rate of royalty payments or remuneration expected from licensing the technology and the direct costs to the institute of seeking protection. The expected remuneration from licensing a technology will be influenced by the economics and marketing factors of the technology and the product to be developed, such as the size of the market, competition, and capital investment needed to exploit the protected technology (Figure 1).

Immediate direct costs to the research institute are the filing or application fees, attorney fees, and the maintenance fee if protection is granted. This can be quite expensive if protection is sought globally. For example, the initial cost of a patent application in major European countries, the USA, and Japan can be up to $10,000 to $20,000 depending on the legal and technical complexity involved (Blackney et al, 1999). The estimated cost of seeking global patent protection may even run in to hundreds of thousands of U.S. dollars. The Patent Cooperation Treaty (PCT), which is administered by WIPO, provides a relatively easy and cost-effective way for an applicant or inventor in a signatory nation to file a patent application in other signatory nations. Under the PCT, rather than having to deal with multiple national patent offices in parallel, the applicant has the ability to determine from the examination report how WIPO views the patentability of an invention and make an appropriate decision. If the WIPO search and examination report are unfavorable, the applicant may choose to not seek patent protection and avoid the costs of filing in the designated offices.

Thus, for a developing country that is a signatory of the PCT, the costs of seeking international patent protection can be reduced considerably. Nonetheless, seeking protection is not without costs. Even though monetary gains by themselves do not determine the decision of a public research institute to protect or not to protect a technology, they are nonetheless important and need to be considered in the decision making process. Although the motive is not to reap monopoly profits, the public research institute has to consider whether the protected item will generate enough demand to attract private sector licensee(s) and make the protection costs worthwhile for the research institute

(Blackney et al. 1999). If the expected monetary benefits from protection are greater than the direct costs incurred by a research institute, the decision will be favorable (Figure 1).

For a public research institute, there are additional variables that enter in the equation on both the cost and benefit sides. These are the economic and social implications of a technology on different groups and on the “public good” in general. For example, the implications of increased cost of inputs to producers, price implications for consumers, effects on the advancement of public knowledge, impact on the accessibility of results for further research, protecting farmers’ rights, etc. (Figure 1).

The decision to seek or not to seek protection of a new technology should ultimately be based on an assessment (formal or informal) of whether the total “benefits” exceed the total “cost” of protection. In the framework of Figure 1, the more the conditions favor the decision “yes” the more are the social and economic benefits of protection, and the more the conditions favor the decision “no” the more are the social costs of protection. The “size” of the benefits and costs and the ultimate decision (yes or no) will, however, depend on the relative importance each of the variable – monetary benefits, direct costs, and public good-- receives from a public research institute. Thus, even if the monetary costs and benefits are favorable towards “yes” (i.e., B is greater than C), but the protected technology is perceived to impose limitations on a farmer's ability and rights to replant saved seed, which may be a very important objective of a public research program, a researcher may decide not to protect a technology. In this case, the negative impact on the public good may far outweigh the monetary gains. On the other hand, even if the size of the market and other economic factors are unfavorable to justify protection (i.e. B is less than C), a public research program may decide favorably if it perceives the need for a public institute to control who uses the innovation and for what purposes is important (i.e., P is positive).

The protection of a particular technology XYZ by a public research institute is thus a complex decision making process based on economics, as well as the desire to serve the public good. Once the decision is made to seek protection, the next important step is to decide on the type and scope of protection.

Decision Issue: what type of protection should a public research institute seek for its intellectual property?

There are many ways to protect the knowledge, technologies and products of research. The most important mechanisms for legally protecting agricultural innovations as envisaged in the TRIPS Agreement are plant variety rights (PVR) and patents. Other forms of protection can be provided through trademarks, trade secrets, and copyrights. Alternatives to these include material transfer agreements (MTAs) of a private contractual nature, which are increasingly being used in public research institutes both at national and international levels (Cohen, Falconi and Komen 2000).

The decision on the type of protection usually depends upon the nature of innovation and the economics of commercialization. The nature of invention determines the type of protection a research program can legally seek. For example, if the new product developed from research is such that it does not strictly conform to the standards of patenting and PVP, the research institute may opt for the trademark or copy right options.[15]

In order to commercialize some inventions (e.g., a method of extracting bio-fuel that reduces pollution), a private firm has to incur a large sum of time and money costs (e.g., testing; generating data; getting approval, certification, and clearance from an appropriate government body). Going for the strongest possible type of protection offered by the legal system, such as patenting, would be most beneficial from the "public-good" point of view. The rationale is that without such strong protection no private company will invest the time and financial capital necessary to develop the product for the market.

Such a case could also occur if the technology involved is complex and requires specialized knowledge, skill and information to commercialize it on a large scale. Restricting the technology by licensing it to a private firm not only makes the technology available to the public but also assures that the product quality and characteristics are maintained in its desired form.

In deciding on which forms of IPR protection to adopt, it is important to consider whether an innovation will have only national application or perhaps wider, even global, relevance. Applying innovations to the needs of farming communities that do not traditionally rely on purchased inputs may not require any IPR protection. In fact, the costs of such protection would far outweigh any commercial benefits. However, if that same innovation has global implications, then some form of protection may well be justified.

In making decisions about the type of intellectual property protection, a public institution needs to assess the most effective way of generating public benefits from an innovation and needs to determine who is the ultimate user/consumer of an innovation that will pay the cost or reap the benefit.

Management and policy issue: How should a public institute use its protected technology?

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[15] For example, one of the researcher at Michigan State University (MSU) imported a cherry tree from Hungary which underwent further research and development at MSU. However, the improved tree did not conform to the guidelines of PVP or the patent law. Michigan State University, therefore, sought trademark protection and has since licensed the product to several private firms (Maredia et al., 1999).

In addition to the decision on the type of protection, a public research institute also faces the decision on how to use and transfer the protected technology for the service of “public good”. There are several options available to a public research institute: Licensing it to others to generate revenues, licensing it to others at zero or minimal costs, using it as a bargaining chip to access other technologies. In the survey of developing country researchers and managers, the respondents were asked to give their personal assessment on the type of strategy that most directly addresses the perceived needs of public research. Sixty percent of the respondents selected the strategy of using the protected technology to generate more revenues for research. About 50% of the respondents gave equal importance to the strategy of licensing it to others at zero or minimal cost and using it as a bargaining chip in license negotiations. Each of the strategy for a public research institute is discussed below. Also, important components of a licensing agreement are discussed in Annex 3.

1. License it to others to generate revenues

One option for the research institute is to license technology to a private firm for an agreed rate of royalty payments. The viability of this option and the success of using this strategy will of course depend on the market value of the technology. Revenues gained from licensing a protected technology may help pay the costs of maintaining the infrastructure necessary for providing researchers with advice on IPR, documenting innovations, preparing applications, and the cost of obtaining protection; the remaining surplus may be channeled back for research purposes.

With decreasing government funding, this option has the potential to increase public research revenues from non-traditional sources. In fact, a majority of respondents of the survey from developing countries’ indicated that they would use this as a strategy for public research institutes to generate more revenues.

However, the empirical question is how significant are the gains from using IPR protection as a strategy for generating new revenues for research. Little formal analysis has been applied to answer this question even in the case of industrialized countries (Heisey1999). Castillo, Parker and Zilberman (1999) (cited in Heisey 1999) show that in the case of U.S., technology transfer revenues cannot pay for university research. In the mid-1990s, the top 10 U.S. universities in terms of technology transfer earnings generated only 2.4% of their research revenues from technology transfer. A study by Parr (1995) found that the first and second most frequently reported royalty rates in the telecommunications, semiconductors, and computer industry was 5% and 2%, respectively.

The most important factors that determine the royalty payments of a technology are: a) the profits expected from the licensed technology; b) the capital investment required to exploit the technology; and c) the risk associated with achieving the targeted results. The rate of royalty payments in agriculture related technologies is speculated to be lower than in other fields because of lower profit margins in agriculture (Heisey 1999). However, even within agriculture, technologies carry different expectations depending on how it will be used and the specific circumstances of exploitation strategies.

2. License it to others at zero or minimal technology fee (or royalty payment)

More fundamental questions for a public research institute concern whether the collaborative arrangement between the licensor (public institute) and the licensee (private firm) will lead to benefits to the society as a whole. Seeking IP protection and licensing it to a private firm should not incur social costs by shifting research priorities to more near-term projects with greater private profitability. Thus one of the options for a public research institute is to license a technology at zero or minimal payback rate (to cover the cost of protection) to promote greater information exchange, speed up the commercialization of breakthrough ideas, and promote competition in the economy.

An issue that often arises in the technology transfer process through licensing is the control over the use of the intellectual property, especially when the researcher has a vision for the development or use of the research results. Since many public researchers have a long-term interest in a particular research project, they may not want to divest all control over future use of intellectual property. Thus, one of the options for a public research institute is to license the use of a given technology such that the public researcher still maintains autonomy on further development and refinement of the technology. The issue of control over further development, and the cost implications for the ultimate consumers of a technology may be an important factor in determining the licensee and the terms of payments of a license agreement.

Whether a public research manager chooses option 1 or 2 as a management strategy, the choice of the licensee will depend upon whether the public institute is able to reach a license agreement, which contains mutually beneficial terms and conditions. The research institute also needs to make a decision on whether a technology will be transferred through an exclusive- or a non-exclusive license agreement. This decision will depend on the technology and the possible uses of technology. If an exclusive license is given then there must be provisions in the license agreement for the public institute to terminate the license and take the technology back.

3. Use it as a bargaining chip to negotiate technologies from private sector

Yet another alternative for public research managers is to use a protected technology as a bargaining or “bartering” chip in negotiations with private sector firms. As the case of Brazil illustrates, the value of EMBRAPA’s “dominating” varieties in the seed market made negotiations on the use of a few herbicide genes with multinational companies relatively straightforward after the introduction of a PBR in incorporating the essential derivation concept. (Sampaio

2000). As more and more agricultural research tools and products become proprietary, public research institutes in developing countries will have come up with means and strategies to access these technologies for research purpose. They can either come up with resources to purchase/license these technologies from the private sector or play a defensive game and develop a suite of bargaining chips that will be attractive to private firms.

5.2 Issues Pertaining to the Use and Access of Intellectual Property from Others

Just as a public research institute is faced with the management and policy decisions about protecting its technology, it is also faced with the management decision issues on the use of and access to intellectual property protected by other research entities. Management decision issues and options pertaining to protecting a technology, discussed in the previous section, may be important only to countries and research programs that are generating "protectable" technologies (e.g., countries with research capacity in advanced biotechnology). However, public research institutes in developing countries are finding themselves on the receiving end of a protected technology more often than the giving end as more often then before, research tools, breeding lines, and products used in a research program are owned as intellectual property by private and public research institutes in industrialized countries. The nature of collaboration between the public and private sector is also changing globally, with the private sector increasingly providing results of the basic research and the public sector conducting the applied research (Pray 2001). This makes the public research systems more productive. But private firms may not collaborate with the public sector for applied research on some economically important crops, unless the public sector agrees to protect certain IP.

The number of international alliances and research partnerships between public and private research institutes in developing and industrialized countries is increasing. These are often brokered through intermediary organizations. For example, both ABSP (Agricultural Biotechnology Support Project at Michigan State University) and ISAAA have facilitated alliances between public NARSs and multinational companies (Lewis 2000, ISAAA 2000). Some NARSs have developed collaborative agreement independently of intermediaries to exploit the potential offered by biotechnology. An example of this approach is a bilateral alliance between PhilRice (the public sector research institute in Philippines) and a private U.S. agricultural biotechnology company (Byerlee and Fischer 2001).

Research partnerships and collaborations between international research centers and the private sector in industrialized countries is also increasing. A survey of international public agricultural research institutes (the CGIAR centers) reveals that most research centers use proprietary technologies and materials in their research programs that affect several mandated commodities specifically targeted for developing countries (Cohen, Falconi, and Komen 2000). The survey recorded 166 cases of international research centers using proprietary research inputs. The three broadest application categories were selectable marker genes, promoters, and transformation systems. These technologies are routinely used and applied by biotechnology research programs at both international and national public research institutes. The technologies and materials of this research are then passed on to conventional crop and animal breeding programs and may become part of the products suitable for dissemination to end-users.

Many of the proprietary inputs used by public research institutes have use restrictions (for research purpose only) and may create complex problems when the finished products are ready for dissemination. A clear understanding of the IPR implications of using proprietary inputs in a research program is therefore essential. In making decisions about the use and application of protected IPs the issues that need to be addressed by a public research institute are whether to license the use of a protected technology or invent around? What terms and conditions to negotiate with other research firms to ensure their freedom to operate? The strategic response to these issues will depend on the economics and legality of the technology involved, but also governed by the overall goal of public research, which is to provide best choices to farmers and end-users of agricultural technologies. An important first step to respond to the issues is to develop institutional policies on IPR that takes into consideration the following issues.[16]

Decision Issue: whether a public research institute should license a proprietary technology or invent around?

Licensing a proprietary technology for use in a research program can be costly as well as restrictive. Licensing a technology from the private sector involves paying a license fee that adds to the cost of conducting agricultural research, which is an increasing constraint on resources. A more important constraint, however, is that licensing the use of an IP technology may restrict the research program's freedom to operate (FTO). Thus, a decision facing a public research institute is whether to go ahead with the licensing agreement and restrict its FTO or invent around by using alternate methods.

One of the alternatives to licensing is to use technologies that are in the public domain. Public domain technology refers to technology that is not protected by intellectual property rights, i.e. not privately owned, classified, or proprietary, or whose protection has lapsed. Such technology comprises 'knowledge spillovers.' Public domain knowledge is often ignored and it has been argued that

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[16] The following website: http://www.cimmyt.org/resources/obtaining_seed/IP_policy/htm/IP-Policy_Eng.htm provides a good example of an IPR policy at an insitutional level adopted by the International Maize and Wheat Improvement Center (CIMMYT), a CGIAR center in Mexico.

developing countries should emphasize efforts to screen this knowledge and to use it to further their own development goals (Acharya 1991).

Exploitation of public domain technology is entirely legal and cannot be contested. Although there could be a time gap between the time of creation and the time when the technology comes into the public domain, this might not constitute a problem for many research programs in developing countries that generally need considerable time to adjust to new technologies. In any case, many innovations will be in the public domain far earlier than is expected on the basis of the maximum protection term. For instance, whether a patented invention actually is protected for 20 years, depends on the patent holders' ability and willingness to pay the periodic maintenance fees to the relevant offices in all countries that have granted the patent. The shortening of product life cycles may result in shorter protection periods for some technologies, as the right holder might not consider it worthwhile to continue to pay the fees to some or all of the Patent Offices.

Another alternative to licensing for a research program is to create its own technology/method/input for use in the research project. Like other issues, decisions about whether a research program should license an IP technology or invent around using its own or a public domain technology would have to be case-specific. The decision will depend on economic factors as well as scientific possibilities and capabilities of a research program. It will also depend on the type of technology in question and how significant is its role in generating the end product of a research program.

Surely, licensing a technology can be costly, but so can be the other options. Looking for alternatives may involve time and money costs in the form of screening technologies in the public domain and creating new technology/methods. It may also affect research program efficiency and prolong the time needed for the generation of research results. Inventing around thus can have social costs that need to be carefully assessed and compared with the social and economic costs of licensing a technology from the private sector.

Management issue: what terms and conditions should a public research institute negotiate to ensure its freedom to operate?

A common legal arrangement by which a public research institute obtains permission to use proprietary inputs is through material transfer agreements (MTAs), followed by licensing. If licensing a technology is the way to go, an important issue for research managers is negotiating the terms and conditions of the MTA or a license agreement so that it ensures their FTO.

Negotiations over rights to use a technology should be one of the first things that need to be addressed when embarking on a research partnership. For a public research institute, it is important that the terms and conditions do not restrict their freedom to:

- Develop technologies for non-commercial sector
- Experiment and use products for more research
- Advance the public knowledge, and
- Provide best choices to their research stakeholders and clients

In negotiating with the technology provider, a research program should make sure that the terms and conditions of an agreement do not infringe upon their rights and responsibilities as a public institute. By the same token, the agreement should not in any way de-motivate the technology provider by including terms and conditions that can negatively impact their profits and increase competition. Thus, the terms and conditions should reflect both the market needs of the private firm and the public goods need of public research.

Fischer et al. (2000) propose a collaborative partnership between the public and private sectors for trait discovery in rice, which exemplifies a fair balance between the "freedom to access" to new knowledge for the public sector and the IP protection for the private sector to recoup its investment in innovation. In this public-private sector partnership, the public sector (IRRI and other strong NARSs) would contribute the required germplasm, and the private sector would contribute molecular analysis techniques and gene product development. The major outputs would be gene discoveries that could be employed in transgenics and molecular markers. The pattern of property rights envisioned in the collaboration is that the biological materials will be made available to the public and private sectors under an MTA. The recipient (i.e., the private sector) is permitted to obtain patents on genes discovered through use of the material, and is required to make rights under those patents available at a reasonable royalty for application in the developing world (and at zero royalty for use in non-commercial markets). It is also envisioned that under this model of partnership, the large number of molecular markers to be derived from the work would also be made freely available to plant breeding programs for food crops in the developing world.

One of the terms and conditions that can be negotiated with in public-private sector partnerships is market segmentation. Byerlee and Fischer (2001) provide several examples of different types of market segmentation (Table 4). A public research institute can give up their rights to transfer or use the results of the research for commercial or export markets, in return for retaining their rights for the domestic and non-commercial markets. Markets could be segmented based on biology, countries, and regions. For example, a public research institute in a developing country can negotiate on giving up their rights to develop hybrid varieties based on a proprietary technology but can still retain its right to develop open pollinated varieties that can be retained by farmers for further planting. Alternatively, it can forego its rights to develop a product for industrialized country markets, but retain its rights to the traditional segments of a developing country markets. Whatever the type of market segmentation, it often requires intense negotiation, the development of trust between partners, and the capacity to enforce agreements on markets. Byerlee and Fischer (2001) note that the result will generally require compromises that introduce imperfections into market segmentation.

In order to strike a favorable agreement, a public research institute should also consider using its proprietary technology as bargaining chips. “Give some to get some” may be a better policy for a public research institute in this changing global IPR system. In order to access and maintain a flow of biological assets, advance public knowledge, and provide access to IP products for more research, a public research institute should use its own IP as a bargaining chip in the negotiation process.

The issue of accessing scientific literature and databases

The outputs of agricultural biotechnology research efforts are not only embodied in physical technologies, but also take the more traditional form of published scientific literature and databases. Accessing these sources of information and knowledge is critical for developing country public research institutes and universities to remain competitive and to benefit from the agri-biotech revolution. These published products of research can be considered international public goods that have wide global spillovers. But they are not easily accessible or accessible only at a cost to research organizations because they are “owned” by private sector (e.g., publishers) and protected by copyright laws. From a global societal point of view, the issue therefore is what should be the best public and private strategies, in economic and other terms, to ensure that science reaps the most benefits.

The Internet provides an unprecedented opportunity to address this problem, and thus help to bridge the divide that separates the 'knowledge-rich' from 'knowledge-poor' nations of the world. Many web sites have been recently developed to fill this knowledge gap. For example, SciDev.Net (www.scidev.net) was recently launched (December 2001) with the goal of providing a focal point for both authoritative information and informed debate about issues such as climate change, human cloning and intellectual property. The website is backed by the world's two leading scientific journals,Nature and Science. Each has agreed to provide free access to a selected number of items from each week's issue. In addition to these journals the project is also supported by the Third World Academy of Sciences, which brings together more than 80 scientific academies from across the developing world. It is hoped that SciDev.Net will serve as a broker between those that have knowledge about science, technology and development, and those who can benefit from this knowledge.

The strategy of market segmentation discussed above might also be one option. A good example in agriculture of this strategy is the negotiation of the copyright associated with the Essential Electronic Agricultural Library (www.teeal.cornell.edu), whereby the full text of 130 copy-righted agricultural science journals is made available on CD-ROM free of royalties to qualifying countries, based on per capita income level (Byerlee and Fischer 2001).[17]

Another option is not to take recourse to IP system and make these resources freely accessible to all. The example of Genbank highlights this model (http://www.ncbi.nlm.nih.gov/Genbank/GenbankOverview.html). It demonstrates how all benefit from having free access to the 16 billion base pairs of primary DNA sequence and the related molecular information that has been submitted to this shared resource by the international scientific community. The information either goes directly to GenBank or is submitted via its counterparts in Europe -- the European Bioinformatics Institute in Cambridge (EBI) -- and Japan -- the DNA Data Bank of Japan (DDJB) (McEntyre and Lipman 2001). As a result of shared free access, GenBank now houses sequence from over 900 complete genomes, including the draft human genome, and some 95,000 species.

GenBank demonstrates that, even in the fiercely competitive world of science, researchers recognize that contributing to large, shared data sets ultimately benefits everyone. However, for this model to be successful, scientists should be willing to place data/information/results in a community archive for the common good, knowing that it can be freely used by anyone. In this age of Internet publishing, this option is becoming more common. Even some leading journals have adopted a policy that requires sequences to be deposited in the public databases, and the corresponding access numbers to be cited in published articles (McEntyre and Lipman 2001).

5.3 Challenges in IP Management for Public Sector Agricultural Research

The discussion presented in the previous 2 sections shows that the protection and use of intellectual property by a public research institute is a complex decision making process based on economics, as well as the desire to serve the public good. In order to comply with the national IPR policies and keep up with the rapidly changing rules of the game, public research institutes in developing countries have to take up many organizational and management challenges that require more human and financial resources, and knowledge, skills and expertise in non-agricultural fields of study. These challenges and options for addressing them are discussed below.

Establishment of an IP management office

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[17] However, some low-income countries such as India and China are excluded, apparently because publishers did not feel they could enforce contracts prohibiting further copying (Byerlee and Fischer 2001).

In order to access and protect IP technologies, a public research institute will need to establish an IP management and technology transfer office. The responsibility of this office will be:

- To develop institutional IPR policies;
- To regulate the division of revenues generated from institutional IP
- To educate and create awareness about IPR among researchers and management personnel;
- To handle the day-to-day management of institute's intellectual properties, including patent filing, applying for PVP protection, doing database searches, negotiate contracts and agreements;
- To act as a research liaison office to help researchers access a proprietary technology;
- To assess the accountability requirements and public expectations regarding innovations produced with public funds.

The capacity to undertake the day-to-day management of institutional IPR is a time-intensive investment often involving opportunity costs in terms of scientists being taken away from their research if an in-house management capacity is not developed. Thus, like any other agricultural research investment decision, the challenge for a research institute is to determine the efficient size and scope of an IP management office so as to not burden the research system, yet fulfill the IP management needs of its researchers and research programs.

Developing negotiation skills and bargaining power

The challenge for public research institutes is also to build capacity in terms of skills, experience and expertise to undertake negotiations with other national and international research entities. In building research partnerships with private sector, it has to safeguard and serve the interests of its stakeholders and clients, especially for whom public agricultural research is the only source of improved technologies.

The key to acquiring skills and power needed to negotiate and bargain favorably is knowledge and information – knowledge about the latest developments in the research arena and information about alternative sources of technology. By keeping informed about the alternative sources of technology a research program can improve its bargaining position in negotiations or technology transfer agreements. Where several public research institutes use the same category of proprietary tools, it may be advantageous to cooperate in the acquisition of those technologies.

One way of monitoring the status of global intellectual properties (especially those that are due to expire) and keeping the developing countries informed about agricultural research is to establish regional or international IP information systems and clearing houses that maintain global databases. These databases should include information of available technologies (from both public and private sources), their proprietary status, terms and conditions of their availability, and their potential utilities and applications to agriculture. In order to reduce the financial burden for individual developing countries, it is suggested by some that these regional centers or "information hubs" should be assisted by various UN agencies in facilitating information flows (Juma and Khalil 1992). CAMBIA, for example, envisions an internet-based patent database that will enable a user to easily access and analyze published patents and patent applications from many countries (www.cambia.org/main/ip_stratgr.htm). Similar databases could be established for public domain technologies in order to make these more readily available in developing countries (Spillane 2000). Byerlee and Fischer (2001) suggest that these information systems may eventually evolve into clearing houses that offer 'one-stop' brokerage services for buying and selling IP.

Understanding and honoring IPR legislation and agreements

New capacity is needed on the part of decision-makers, managers, and scientists to provide clarity on biotechnology policy and research agenda. Researchers and decision-makers need special training in the management of IPRs, including negotiation exercises, illustrations and case studies of public-private partnerships, end-user considerations, and other management responsibilities.

Research managers need also be made aware of the legal obligations of entering into a MTA and other agreements. A research institute must be in a position to honor those obligations. For example, when confidentiality obligations are imposed, a research institute must police the handling of the material supplied. This may require the establishment of a secure system of operation and place researchers and visitors under confidentiality obligations. In the event of a violation of the MTA, the research institute is likely to be sued rather than the responsible individual, because, the research institute is the signatory to the MTA. Alternatively, the supplying firm may bar the violating institute from receiving further materials, which can damage the entire research program.

Meeting the costs of IP management

Building capacity in IP management at institution level involves both fixed and variable costs. The fixed costs include the establishment of an IP management office, building in-house human resource capacity in IP management, providing training to researchers and managers, and creating awareness among researchers; all of which can be quite costly. Research institutes and programs also incur variable costs in the form of patent filing fees, fees for database searches, legal fees for preparation of applications for plant variety, patent and other forms of protection, negotiation costs and costs related to accessing a specific piece of proprietary technology. For research systems that are at the forefront of biotechnology, establishing who has what rights of ownership over new processes and plant varieties could be a costly business, especially when firms take recourse to litigation to determine who has what rights and to secure their markets.

Obtaining a patent can be quite expensive. Patent applicants must apply for patents in every country where they want protection, periodically pay fees to maintain the patent and pay patent agents costs. The costs of filing a patent vary greatly, ranging from $355 to $4,772 in 32 countries surveyed in the early 1990s. Preparing a US patent application in the early 1990s costed about $20,000, and in the EU about twice that. PBRs, however, are cheaper--about a tenth the cost of a patent (Lesser 1997).

At the national level, the implementation of IPR will require a well organized patent office and a PVP office. The costs of establishing and maintaining such offices may be high. The US government spends over $300 million each year to operate the Patent and Trademark Office. The costs for running the Brazilian National Institute of Industrial Property (INPI) amount to approximately US$ 30 million annually. In developing countries, these offices typically lack personnel and funds (Braga 1990).

The administrative costs of the patent system may be significant for some developing countries, but there are many ways to improve the effectiveness of the system without imposing a major financial burden on these countries. User fees, international cooperation (e.g. under the patent cooperation treaty or the International Patent Documentation Center), regional arrangements, and networking with patent offices in industrialized countries, are some of the available alternatives. The computerization of patent data bases have made patent documents as well as their bibliographic results and capabilities accessible in developing countries to approximately the same degree as they are in most industrialized countries. In addition, companies have been set up to secure copies of patent documents and make them available for sale in many formats such as microfilm, microfiche, CDs or full-sized paper copies. Moreover, WIPO and the European Patent Office have special programs designed to assist developing countries in this respect. The office of UPOV places special emphasis on international co-operation in the testing of plant varieties and has developed ‘UPOV Test Guidelines’ for use in this connection (http://www.upov.int/tg-rom/start.htm).

5.4 Concluding Comments

The opportunity to protect plant and animal intellectual property raises several issues, opportunities and challenges for a public research institute. In making decisions about the use and protection of an IP technology, a public research institute has to weigh benefits against the social costs to farmers and consumers, and the public expectation that all intellectual property created by a public research program should be made available free of cost and without restrictions. As public agricultural research programs create innovations, seek to serve the public and bring forth their products to market, partnerships with private companies are becoming inevitable. The need for a private sector intermediary to develop and market an agricultural biotechnology product makes it necessary for a university to seek protection of its intellectual property.

The protection of intellectual property by a public university is a complex decision making process based on economics, as well as the desire to serve the public good. In making decisions about the use and protection of an IP, a public institution needs to assess the most effective way of generating public benefits from an innovation. Protecting intellectual property and restricting its use for the primary purpose of generating income through royalties is not compatible with the responsibilities of a public institution. It is important to note that although public agricultural research institutes are responding to the new IPR scenario they are still in the business of public research and producing non-proprietary technologies that are transferred to farmers and other clients without cost. In fact, most of the technologies developed by public agricultural research systems worldwide fall into this category. However, in special instances, protecting an innovation and assigning its production exclusively to one, or non-exclusively to more than one, company may be the most desirable action to ensure the promotion and utilization of an innovation.

6. Need Assessment of Public Agricultural Research Institutes in the Area of Intellectual Property Rights

The above discussion shows that as the implementation of the IPR policies in developing countries progresses, public research institutes are confronted with many challenges in managing the intellectual property generated by their own research and accessed from others. In the survey conducted by the author, the respondents from public research institutes of developing countries were asked to assess the need for external assistance in implementing the IPR framework in their institutes by selecting different areas listed in the questionnaire. Based on the assessments of the respondents, the areas identified as the most in need for external assistance are listed in Table 5.

All the areas listed in the questionnaire were selected by respondents as important areas that need to be strengthened in a public institute. These can be broadly grouped into four main categories:

1. Human resources development
2. Research and marketing tools
3. Institutional capacity building
4. Financial resources

Many of these “need areas” were discussed above as challenges confronting research managers in public research institutes. Interestingly, the need to create awareness by training researchers and managers on IPR related issues, and the development of negotiation skills were identified as important “need areas” more frequently than the need for financial resources to cover the IP protection and accession costs. IPR is a novel concept in most agricultural research institutes of developing countries and this response indicates the importance public researchers give to the need for human resource development in implementing the IPR framework at an institute level. None the less, the economics of IPR is a major concern of public research systems, and they need to come up with strategies to finance their IP and technology transfer offices, recover the costs of seeking protection, and increase research funding to cover the cost of accessing proprietary technologies.

One of the areas identified as the most important “need area” by the respondents is the research and marketing tools to value PVP and patents. A decision question often faced by a research manager is whether or not to protect a research result/product. The complexity of this decision was illustrated in the conceptual framework given in Figure 1. In order to gain an understanding on the magnitude of potential benefits (B), private firms usually conduct an in-depth marketing study of a technology. Some well-known methods and tools used in making such decisions are investment rate-of-return models and discounted cash flow analysis.

A full-blown marketing study, as undertaken by many private firms to answer this question, is too time-consuming and expensive for the needs of a public research institute. What a public research manager needs are the research and marketing tools that can help them detect “valuable” innovations that have market potential and do not diminish the public goods aspect of research. The traditional approaches to market studies are not adequate to address the complexity of decision-making faced by agricultural research managers. Public research institutes need a quicker and more user-friendly marketing research tools that can be implemented in-house to aid them in making strategic decisions about IP protection, and the inclusion or exclusion of specific terms and conditions in a license or a technology transfer agreement.

This is often a neglected area in training workshops aimed at educating researchers and managers on IPR issues. One of the possible reasons for the neglect could be the lack of availability of practical tools and methods. Decisions about patenting or seeking PVP are often based on serendipity and personal judgements of a researcher or a technology transfer coordinator. Even the decision making at public research institutes in industrialized countries is often based on informal, “back-of-the-envelope” assessments of the potential value of an invention.

Due to the complex nature of making IPR decisions, problem solving and decision-making in actual practice tends to be more of an art than a science.

However, as more and more public research systems attempt to enter the market of intellectual properties, they will need a systematic approach to aid them in making decisions and building partnerships with the private sector on equal footings. Public research institutes, therefore, need market research that will:

- assist them in IPR investment decisions,
- recognize the rapid change in agricultural product markets,
- use a systemic rather than industry-wide approach,
- estimate the market value of patents, PVP, and other intellectual property for new and potential products,
- be cost-accessible to the research institute.

Assistance in this regard is much needed and will require active participation of and collaboration of IP management offices with researchers in the social sciences units, both within or outside, of a public research institute.

7. Conclusions and Suggestions for Further Actions

The drive towards stronger worldwide IP protection has intensified as a result of changes that have taken place in the global technology system, notably in the OECD countries during the past 20 years. After initial reluctance, many developing countries have accepted the TRIPS Agreement of the WTO. A number of countries have already revised their IPP laws in accordance with the demands of industrialized countries, and many more are in the process of modifying their IP systems.

Areas of IP protection which are relevant for agriculture and for which TRIPS mandates a minimum level of protection are patents, plant variety protection, commercial marks such as trademarks and geographical indications, and trade secrets. The focus of this paper was on the implementation status and concepts related to plant variety and patent protection in agriculture. Under the new IPP system, patent protection must be granted for biotechnological inventions and pharmaceuticals. This requirement restricts the use and duplication of protected biotechnological processes and products, including living material and pharmaceuticals. Plant varieties are required to be protected by patents or a *sui generis* system such as the plant breeders' rights. The upgrading of IPP in developing countries is expected to stimulate the transfer of technology and scientific co-operation with industrialized countries, as well as innovative activities in developing countries themselves.

However, concerns have been raised about the impact a stronger IPR legislation on patents and PVP will have on the free international exchange of plant material, the use of this material in breeding programs, and the on-farm seed saving by farmers in developing countries. The balance between benefits and drawbacks of a high level of IPP will probably differ across developing countries and sector of agricultural technology. Policy options and their implications for developing countries were discussed with respect to IPP of agricultural technologies and plant breeding. These policy options include policies that run counter to the new international IPP standard, continuing opposition to restrictive terms of the TRIPS Agreement, policies that exploit the ambiguities and loopholes in international IPP agreements, and policy options that mitigate adverse impacts of IPP.

With the global trend in private sector R&D, application of biotechnology, and the use and protection of intellectual property in agriculture, agricultural scientists and research managers in public institutes are facing complex questions and micro-level management decisions about the use and protection of IP. The paper also discussed the issues, concepts and challenges confronting researchers and managers of a public agricultural research institute in developing countries. There are many factors that determine the decision about whether or not to protect a technology, what type of protection to seek, and how to transfer the technology developed by a public research institute. Some of the factors discussed in the paper are standard economic variables such as the cost of protection, market size of protected technology, potential rate of royalty payments or remuneration expected from licensing the technology, current and future product market competition, etc. But for a public research institute, there are additional variables that enter in the equation on both the cost and benefit sides. These are the economic and social implications of a technology on different groups and on the "public good" in general. The protection and use of intellectual property by a public research institute is thus a complex decision making process based on economics, as well as the desire to serve the public good.

In order to comply with the national IPR policies and keep up with the rapidly changing rules of the game, public research institutes in developing countries need to take up many organizational and management challenges. These challenges and options include the establishment of an IP management and technology transfer office, developing negotiation skills and bargaining power, understanding and honoring IPR legislation and agreements, and meeting the financial burden of maintaining an IPR system in a public research institute.

Intellectual property is a novel concept for many developing countries, and especially so for public research institutes. The four broad areas identified by survey respondents that need external assistance to implement the IPR framework in public research institutes were: human resources development (training and awareness creation on IPR issues, negotiation skills), research and marketing tools to value intellectual properties, institutional capacity building (establishment of an IP management office, developing guidelines, policies, handbooks, etc), and financial resources to meet the expenses of protecting and accessing IP technologies.

The overview of issues, concepts and challenges presented in this paper reinforce the importance of and need for further actions in the following areas of IP policy and management:

1. Continued technical and financial support for institutional and human resource capacity building in IPR in national agricultural research systems.

2. Continued research efforts to learn more about the implications of changing IPR framework on agricultural research sector in developing countries

3. Development of research and marketing tools to aid decisions related to agricultural IPR

National policymakers and directors of NARS can draw assistance in these areas from a number of alternative sources to help them implement their IPR options. These sources include international organizations such as WIPO, UPOV the World Bank, the CGIAR centers, and other public and private research organizations. The international donor community needs to continue their support to developing countries in building human resources, institutional capacity, and setting up IP management offices at public research institutes so that they can take up the challenge of adapting themselves to the new global competitive environment of research and development.

Developing countries can also seek regional and international cooperation in creating an adequate infrastructure in their countries and in training personnel. An alternative to reducing some of the cost implications of implementing the IPR policy is to allow for the centralization of certain technical tasks at a regional level.

The international research community needs to increase their research efforts and investigation on the theoretical and practical implications of increased IPP on agricultural research environment and technologies generated for farmers in developing countries. Further research on development and application of marketing tools and methods to address the decision problems facing researchers and technology transfer managers is also needed to avoid making uneconomic IP decisions that is a drain on the research system.

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Annex 1

E-Mail Questionnaires and Summary of Survey Respondents

An e-mail survey questionnaire was sent in February 2000 to 84 researchers and administrators in 28 developing countries. Twenty-seven responses were received to this initial survey. The countries and type of institutions represented by the respondents of this survey are:

Country	Public Organizations/ Government Sector	University	Private/NGO Sector	Total
Bangladesh	1			1
Barbados		1		1
Brazil	4	1		5
Chile	1			1
China		1		1
Costa Rica		2	1	3
Ethiopia	1			1
India		1	2	3
Indonesia		1	1	2
Philippines	2			2
Rep. of Korea	2			2
South Africa	1	1		2
Sri Lanka		1		1
Thailand	1			1
Uganda	1			1
Total	15	9	3	27

In late March 2000 a follow-up short survey questionnaire was sent to 13 researchers/administrators from 12 countries to obtain (or confirm) the missing information on the status of implementation of the Intellectual Property framework. The author received eight responses to this survey as follow:

Country	Public Organizations/ Government Sector	University	Private/NGO Sector	Total
Bolivia	1			1
Brazil	1			1
China	1			1
Colombia	1			1
Israel		1	1	2
Kenya	1			1
Uganda	1			1
Total	6	1	1	8

E-Mail Survey Questionnaire (February 2000)

1. **Respondent's Country: _________________________**

2. **Type of Organization you are involved in *(choose a, b, or c)*:______**
   a. Public organization/government
   b. University/college
   c. Private industry

3. **What is the status of the implementation of the following components of an IPR framework for agriculture in your country:**

   a. In place and implemented
   b. Pending for approval
   c. A draft framework in preparation
   d. No steps have been taken

   (choose a to d for each of the following component)
   Plant variety protection:____
   Plant patent law:____
   Patent law to protect plant and animal technologies:_____

4. **What kind of institutional framework exists at the Country-level to implement IPR in agriculture**

(Respond YES or NO for each of the following)

National Plant Variety Protection (PVP) Office:_____
National Committee/Focal point to deal with IPR issues:_____
National Patent Office:_____
World Trade Organization (WTO)/ IPR Contact Point:_____

5. **What kind of institutional framework exists at your institute-level to implement the IPR policies**

(Respond YES or NO for each of the following)

IPR and technology Transfer Office:_____
Institutional IPR policies/guidelines/handbooks:_____
IPR and Technology Transfer Coordinator/Manager:_____

6. **Have you or your research institute been involved in any of the following intellectual property (IP) related activities?**

Respond YES or NO. If YES, indicate whether at personal level (PL) or at institute level (IL).

Negotiation for research and license agreements:_____
Negotiation for material transfer agreements:_____
Plant Variety Protection (PVP) application:_____
Application for plant patents:_____
Application for patents on technologies:_____
Accessed proprietary technology from others:_____
International patenting (outside your country):_____

7. How many plant variety protection (PVP)/patent applications does your institute file per year?

Give an average estimate (a range will do) over the last 2 years, If zero indicate so.

PVP:______
Plant patents:______
Other patents:______

8. Please give your personal assessment of the following trends and situations as it affects a PUBLIC agricultural research institute in your country

(A) What will be the impact of a stronger IPR policy in your country on:

(Please DELETE the inappropriate response)

1. Private sector investment in research: Increase Decrease Don't know
2. Public sector investment in research: Increase Decrease Don't know

(B) How will the global trend in the use of IPR protection affect the accessibility and transferability of research inputs and outputs from/to international public research community?

(Please DELETE the inappropriate response. KEEP only that applies)

Will not affect Will affect negatively Will affect positively

(C) Which type of strategy will most directly address the perceived needs of PUBLIC research?

(Please DELETE the inappropriate response. KEEP only that applies)

a. Seek no protection at all
b. Seek IP protection but make the technology available free for use to others
c. Seek IP protection and license it to others to generate more research revenues
d. Seek IP protection and use it as a bargaining chip to negotiate technologies from private sector
e. Other. Please specify:____

(D) According to your assessment, which of the following areas need to be strengthened or are in need of external assistance in order to implement the IPR framework in your institute.

(Keep all that applies. Delete that which does not apply)

a. Establishment of an IP management office/ focal point
b. Creating awareness and training researchers and administrators in IP policies
c. Development of institutional IPR policies/guidelines/handbooks
d. Skills to negotiate research and license agreements/ material transfer agreements
e. Research and marketing tools to estimate the market value of patents and PVP
f. Funds for accessing proprietary technology
g. Funds for filing and maintening patents, PVP and other forms of IP protection globally.
h. Other. Please specify:____

E-Mail Short-Questionnaire (March 2000)

1. Country:___________________

2. What is the status of the implementation of the following components of an intellectual property protection framework for agriculture in your country:

(choose option a to d listed below for each of the following component)

Plant variety protection:______
Plant patent law: ______
Patent law to protect biotechnology products and processes:______

a. In place and implemented
b. Pending for approval
c. A draft framework in preparation
d. No steps have been taken

Annex 2

Consequences of Stronger IPRs on Technology Flow and Research Investment in Developing Countries: What is the Evidence?

The interests of industrialized and developing countries in one internationally harmonized IPP system are often presented in the debate as if they are complementary. In general, it is assumed that strengthening the IP system in developing countries will:

- Encourage technology transfers to developing countries,
- Facilitate access to advanced foreign technologies,
- Stimulate foreign investments in advanced technology,
- Encourage the development of products and plant varieties especially for developing countries' markets, and
- Stimulate endogenous private sector innovation in advanced technologies.

Whether acceptance of the new international IPP standard is indeed the best option for all developing countries to catch up or to keep pace with the technological developments in industrialized countries is uncertain and controversial. Here we present a review of the general literature on the economic and social effects of IPRs on technology transfer and **research** investments.

IPR and technology transfer

There is little empirical evidence about the impact of patents and PVPs on the rate of technology transfer or on the stimulation of local **research** in developing countries (van Wijk et al. 1993, Seibeck et al. 1990).

The effects of patents on technology transfer are disputed. One view is that they assist the technology transfer process in two ways: 1) the published patent title discloses information to the benefit of other researchers. 2) The ability to retain control over their technologies allows companies to transfer complementary skills to other countries--either through licensing agreements or through foreign direct investment (Braga 1995, Henderson et al. 1996). According to this viewpoint, IPRs can assist in the diffusion process of new knowledge within and between economies. Patents provide published information, which other researchers can also use to develop innovations. The World Bank report (1999) suggests that the level of IP protection appears to influence the degree of foreign direct investment (FDI), the vertical integration of multinational firms, and direct technology transfers through technology sales and licensing agreements. However, the relationship between protection and FDI is not well established according to other studies.

Another view, however, is that IPRs may restrict the free flow of new knowledge and scientific information, and thus inhibit scientific creativity and technological change that traditionally occurred through imitation (Helpman 1993). In developing countries, the absence of patents enables their infant industries to examine and copy products and develop local production capacities--as Swiss industry did in the 19th century. This may inhibit inward investment but it may also produce net economic benefits for the country.

Theoretically it is far from clear that all countries should be required to maintain the same level of IPP (Trebilcock and Howse 1999). If a country has limited innovative capabilities and primarily consumes foreign innovations, Trebilcock and Howes argue that stronger IPRs may lead to "at least short-term consumer welfare losses and may discourage imitation and adaptation by competitors, which themselves constitute valuable economic activities".

Professor Lester Thurow of MIT's Sloan School of Management argues that the experience of economic history is that "copying to catch up is the only way to catch up" (Thurow 1997, pp. 95-103). But others believe that this is overstated. Moreover, a large share of knowledge "needed" in developing countries (especially the poorest ones) is in the public domain and not covered by IPRs (including for agriculture) (Braga et al. 1998).

IPR and investment in R&D

In theory, stronger IPRs should encourage more research and development in countries where they exist. But there is "limited empirical evidence" even in industrial countries that IPRs protection leads to increased investment in R&D. This is partly because of the difficulty of separating cause and effect--IPRs may stimulate more investment, but countries that invest more in **research** demand more protection.

There are a few studies that examine the effects of PVP on plant breeding research in the U.S. An assessment by Butler and Marion (1985) found that the PVP Act in the U.S. stimulated the development of new varieties of two major self-pollinating field crops -- soybeans and wheat. These crops are difficult to hybridize and therefore had traditionally attracted a much smaller private sector investment in **research** relative to hybrid crops such as corn. Butler and Marion (1985) concluded that the PVP Act did not significantly affect public sector crop breeding, when all crops were considered. At the time of their assessment, they felt that neither the costs nor the benefits of the PVP Act were particularly striking.
More recent analysis by Alston and Venner (1998) concluded that the PVP Act in the U.S. has contributed to increased investment by state agricultural experiment stations in developing new wheat varieties. But they did not find any impact on the private sector efforts in developing conventional wheat varieties. In an innovative econometric study, Foster and Perrin (1992) found that the number of

PVP certificates increase: a) with the value of the crop, b) as the cost of enforcement decreases, c) for crops with greater concentrations of commodity producers, and d) for horticultural crops. None of these conclusions, notes Butler (1996, p. 28) ”are surprising”. He further notes that there is insufficient evidence to generalize the benefits of the establishment of property rights in plant material.

An important issue for developing countries is whether or not PBR in their countries is important to U.S. seed companies who export seeds. According to Butler (1996) PBRs do not appear to be as important a stimulant for exporting seeds as developing hybrids. The related question on the impact of the introduction of PBR on local seed production and **research** in developing countries is still relatively unexplored. The study by Jaffe and van Wijk (1995) is one of the few studies that examine these impacts in Latin American countries. One of the conclusions of this study was that the PBR protection in Argentina (which was the only country examined that had enforced PVP act) seems to have prevented a reduction in **research** expenditure in soybean and wheat, rather than having stimulated additional **research** expenditure for these crops.

There are many reasons and prevailing conditions in developing countries that often prevent investment stimulation in R&D. These include:

- Infrastructural obstacles to IPP enforcement
- The dominance of public research
- The focus of domestic firms on mature technologies
- Little interest of multinational enterprises to innovate in developing countries.
- Small size of the markets for high technology products.

Stronger IPRs may lead to a higher cost of acquiring knowledge and so may adversely affect follow-on innovations that draw on inventions whose patents have not yet expired. Tighter IPRs, notes the World Bank, may actually slow the overall pace of innovation. However, there is no systematic empirical evidence confirming this, just as there is none on the positive impact of IPRs on increased **research** (World Bank 1999, pp 34-35). The Bank suggests IPRs can disadvantage developing countries by increasing the knowledge gap and by shifting bargaining power toward the producers of knowledge most of whom reside in industrialized countries (World Bank 1999).

An argument in favor of stronger IPR is that it gives private sector a greater incentive to develop products useful for developing countries, such as drugs against tropical diseases that have been neglected by the pharmaceutical industry. Stronger IPRs may also increase incentives for local research although developing countries do not have the same traditional reliance on IPRs as is common in most developed countries (Lesser 1997).

Given the lack of reliable empirical data, predictions about the likely economic effects of stronger IPRs on **research** investment in developing countries are not substantiated. Some tend to emphasize the likelihood of increased royalty payments to foreign innovators, the corresponding loss of investment opportunities in domestic research and development; higher prices for consumer products subject to monopoly rights; and greater dependence on imports in general (Braga 1995, Lesser 1994). Taking the bleakest view, a developing country stands to gain only when a foreign invention affords solutions of particular local utility that would not otherwise obtain sufficient investment in R&D.

Annex 3

Important Components of Licensing Agreement[18]

A license agreement is a personal, revocable privilege that gives the licensee a right not to be sued by the licensor for using an invention. The license is primarily used for voluntary exchange of an invention for money or some other consideration. Although there is no one license that will work in all situations, there are provisions that are common to most licenses. Most of these common requirements are dictated by contract law—that is they apply to all technology licenses, irrespective of the fact that the license is agricultural biotechnology or a mechanical device. A number of these 'common' provisions are discussed here.

1. **The parties:** Usually the parties of the license are named in the first paragraph of the license agreement. The licensor is the party that is licensing, and the other party is the licensee—i.e., the one obtaining the right to use a patent/technology. After the names and addresses of the parties, a short-hand, capitalized notation is given in parenthesis, which is used in the rest of the document.

2. **Whereas clauses:** This portion of the license gives the basis for the agreement. These clausees list certain facts about the licensee, the technology and the licensor which simply state the position of the two parties to make the license arrangement possible.

3. **Definitions:** Definitions are critical in technical and scientific documents and especially in legal documents. Definitions are very important in the license agreement because many terms have more than one meaning. It is important that there is no ambiguity in the license and that both parties understand the terms of the agreement.

4. **Grant of license:** This is a very important part of the license. Through this provision the licensee is granted the right to manufacture, sell or use the invention. The licensee may be granted an exclusive license or a non-exclusive license. The exclusive license assures the liccensee that the invention will not be licensed to any other party for commercial use. With a non-exclusive license, the licensee may have competitors because the licensor can license the technology to another party or parties. The exclusive license can have variations too: the license can be exclusive for a geographic region rather than worldwide, or for a geographic region rather than worldwide, or for a particular product rather than for all products which could be produced using the technology. The term of this license can be limited or can last for the life of the licensed patents and new patented improvements which are added to the license as required. If the license is exclusive and the

[18] Adapted from: Erbisch and Fischer (1998)

licensor wants to continue to do research on the IP it is necessary to add a statement to the granting clause that the licensor reserves the right to continue to do non-commercial research and development.

5. **Financial considerations:** Usually the licensor does not grant the license without some financial consideration. There are three basic areas for financial consideration: initial payment, royalties and patent costs. The amount of initial payment is agreed through negotiation. The royalty payment is usually based on the sale of the product, and is usually a percentage of the net selling price. Patent costs are very high, especially when foreign protection is also sought. The license provides that the licensee pays all these costs and in the case of foreign patents, the licensee is given the responsibility of deciding the countries to file. In some instances, the licensee negotiates the right to deduct a portion of the patent costs from royalties.

6. **Research support:** In the case of university technologies few are completely developed and most need further research. The licensee is given an opportunity to have the inventor continue research on the invention. The actual research will be governed by a separate research agreement, but the fact the licensee will support research can be noted in the license agreement.

7. **Reporting requirements:** In order to ascertain the commercialization of the technology and the basis for royalty payment the licensee is required to submit required periodic reports. The royalty payment is due at the time the report is submitted. Ther provision on diligence also has reporting requirements, but these reports are required only for a limited time and contain information of steps taken toward commercialization; these reports are very different from the required royalty-type reports.

8. **Diligence:** This provision is included in the license to assure the licensor that the licensee will move ahead commercially with the invention. The reporting requirements of this provision provide the licensor the satisfaction of knowing how the invention is being developed for commercialization.

9. **Termination:** This provision provides a means for the licensee to terminate its relationship with the licensor, as well as for the licensor to terminate the arrangement. For the licensor to terminate and recover the technology the ocnditions must be such that commercialization of the licensed technology is in jeopardy. Without this provision the licensee could shelve, in some manner, the licensed technology and the licensor's technology would never be commercialized.

10. **Liability/warranty:** Once the licensee begins to make, sell and/or use the licensed technology, the licensor does not want to be responsible or liable for product so a provision provides that the licensee is responsible. While the licensor will have used a patent attorney to draft and prosecute protection for the invention, and will have been granted a patent by the national patent

office, the licensor still cannot be sure that some company will not sue for infringement. Therefore, to protect itself the licensor included a provision stating that it does not guarantee that the ‘patent will be free of claims of infringement’.

11. **Use of names:** One of the ways in which the licensor is able to control the licensee is by allowing the licensee to use the licensor’s name in advertizing. This prevents the licensee from using the licensor’s name to endorse a product of imply that the licensor warrants or guarantees the product.

12. **Agreement governance:** The licensor wants to have any legal actions taken care of near the licensor’s facilities to minimize any legal costs. This provision of the agreement names the geographic area in which any legal action brought against the licensor by the licensee will be held. If the university licenses a technology to a company outside of the country, the provision will also state that the laws of the USA govern.

13. **‘Boilerplate’**: Certain provisions included in a license agreemetn must be included because of contractual considerations. These provisions are rarely negotiated. Often these provisions are given the general name of ‘boilerplate’. Both the licensee and the licensor know these provisions will be in the agreement and accept this condition.

Table 1: Key issues and salient features of the TRIPS Agreement with respect to patents and plant varieties

<u>Patents</u>	
Scope of protection (Art. 27)	Protection should be available for any inventions, whether products or processes, in all fields of technology. Inventions that threaten public order or morality need not be patented, provided the commercialization of such inventions is also prohibited. Most biotechnological inventions must also be protected, but plants and animals and essentially biological processes for the production of plants and animals (excluding microorganisms and microbiological processes) may be exempted from patent protection.
Non-discrimination (Art. 27.1)	The Agreement requires non-discrimination in the granting of patents and the enjoyment of rights in relation to the field of technology, the place of invention and whether patented products are imported or locally produced.
Terms of protection (Art. 33)	The duration of protection must not be less than 20 years from the date of filing of the patent application
Other uses without authorization of the patent holder (Art. 31)	In principle, no restrictions are placed on granting compulsory licensing and government use of patents. However, these practices must respect a number of conditions to prevent patent-holders' rights being undermined. Authorization of such use should be considered on its individual merits. The detailed conditions for granting these authorizations are listed in the Agreement.
Process patents (burden of proof) (Art. 34)	Reversal of the burden of proof in civil proceedings relating to infringements of process patent is to be established in certain cases.
<u>Plant varieties</u> (Art. 27)	Plant varieties, including seeds, must be protected through patent or alternative *sui generis* means.

Source: Adapted from UNCTAD (1996)

Box 1. Important mechanisms for legally protecting agricultural innovations

Patent protection: A patent prevents someone from making commercial use of what is claimed in the patent without the authorization of the patent holder. To be patentable, an invention must be: non-obvious, novel, and industrially applicable in some way. Patents can be given for products and processes and are limited to a fixed period --at least 20 years under TRIPS-- after which the invention moves into the public domain and can be used by anyone. Patents only apply in the country in which they are granted. In return for the temporary partial monopoly granted by the patent, the inventor must make a full disclosure of the nature of his/her invention. Others can use this disclosure to invent something better, but sufficiently different, so as not to infringe the claim of the original patent.

Plant variety protection: Plant variety rights (PVRs) also referred to as "plant breeders rights" (PBRs), are rights granted by the state to plant breeders to exclude others from producing or commercializing material of a specific plant variety. To be eligible for PVR, the variety must be novel, distinct, uniform and stable in its essential characteristics. Under the International Union for the Protection of New Varieties of Plants (UPOV) 1991 convention, a plant breeder is conferred the exclusive right to do or to license the following acts: produce or reproduce the material, condition the material for the purpose of propagation, offer it for sale, sell, import and export the material, and stock the material for the above purposes. The minimum duration of PVR is 25 years for trees and vines and 20 years for other plants.

Trademarks and registrable marks: A trademark is a sign used to indicate the origin of goods or services. Legal protection is provided for trademarks through a system of registration. To be registered as a trademark, a sign must be represented in a visible form such as names, invented or existing words, letters, numbers, pictures, and symbols, or combinations of these signs. Registration of marks confers protection against emulation by traders using identical or substantially similar marks.

Geographic marks and appellations of origin: A specialized form of trademark that identifies that a product or service originates in a country, region, or particular place. The false or deceptive indication of source is actionable,

Confidential information and trade secrets: In the case of contracts with employees or researchers, most common law systems imply a contractual term obliging employees not to divulge information that is considered to be an employer's property. Whether an information is protectable as a trade secret depends on: 1) the extent to which the information is known to the employees and by persons outside the relevant business, 2) the extent of measures made to guard its secrecy, 3) the value of the information to the business and to competitors; 4) the amount of effort or money expended in developing the information, and 5) the ease or difficulty with which the information could be acquired or duplicated by others.

Copyright: Copyright is concerned with the protection and exploitation of the expression of ideas. Copyright laws confer the right to prevent unauthorized persons from copying a work. To be protected as copyright, ideas have to be expressed in an original way. Subject matter of copyright protection includes literary artistic and literary works, research notes and reports, computer programs and databases.

Material transfer agreements (MTAs): MTAs are private contracts between two institutions that offer a form of IPR covering materials not generally protected by patents. MTA are especially important in the exchange and use of plant genetic resources. MTAs, followed by licensing, are extensively used by publicly funded agricultural research organizations.

Source: Adapted from Blackeney, Cohen and Crespi (1999)

Table 2: Status of implementation of PVP and Patent laws in selected developing countries

Country	Member of WTO [a]	Member of UPOV [b]	Latest UPOV Act to which a country's law conforms	Status of implementation [c]	
				PVP [d]	Patent law to protect biotechnology products and processes
Argentina	Yes	Yes	1978	A	A
Bangladesh	Yes	No	--	B*	D*
Barbados	Yes	No	--	C*	D*
Bolivia	Yes	Yes	1978	A*	D*
Brazil	Yes	Yes	1978	A*	A*
Chile	Yes	Yes	1978	A*	A*
China	No [f]	Yes	1978	A*	A*
Colombia	Yes	Yes	1978	A*	
Costa Rica	Yes	No	--	B*	D*
Egypt	Yes	No	--	B	B
Ecuador	Yes	Yes	1978	A	
Ethiopia	No	No	--	D*	D*
India	Yes	No	--	A	C*
Indonesia	Yes	No	--	B*	B*
Israel	Yes	Yes	1991	A*	A*
Kenya	Yes	Yes	1978	A*	D*
Korea	Yes	No	1991	A*	A*
Malaysia	Yes	No	--	B	-- [e]
Mexico	Yes	Yes	1978	A	A
Morocco	Yes	No	--1991	A	
Myanmar	Yes	No	--	C	D
Nepal	No	No	--		
Pakistan	Yes	No	--	B	
Panama	Yes	Yes	1978	A	
Paraguay	Yes	Yes	1978	A	
Peru	Yes	No	1991	A	
Philippines	Yes	No	--	C*	C*
South Africa	Yes	Yes	1978	A*	A*
Sri Lanka	Yes	No	--	C*	D*
Tanzania	Yes	No	--		
Trinidad and Tobago	Yes	Yes	1978	A	A
Uganda	Yes	No	--	C*	C/D*
Uruguay	Yes	Yes	1978		
Thailand	Yes	No	--	A*	
Venezuela	Yes	No	1991	A	
Vietnam	No	No	--	B	-- [e]

Zimbabwe	Yes	No	1978	A	

Source: Author's survey (2000) and published sources. Those marked with * are based on the survey.

[a] As of July 2001 (source: http://www.wto.org)

[b] As of August 6, 2001 (source: http://www.upov.org)

[c] The letters indicate the following status. A = In place and implemented
B = Pending for approval
C = A draft framework in preparation
D = No steps have been taken

[d] All countries report protecting plant varieties by a *sui generis* system (e.g., plant breeders rights).

[e] Current patent law may be able to handle any submission to patent genetically modified organisms.

f On November 10, 2001, WTO's Ministerial Conference approved the text of the agreement for China's entry into the WTO. China will become legally a member 30 days after the WTO receives notification of the ratification of the agreement by China's Parliament.

Box 2. Plant Variety Protection under the UPOV Convention

Prior to 1961, a number of States provided limited rights to plant breeders but the criteria for the grant of rights differed from State to State and even the concept of variety was not seen in the same light in all States. There was no guarantee that the rights that a State was prepared to grant to its own nationals would be extended to the nationals of other States. Where varieties are protected in one State but not in another, distortion of trade may result. Difficulties of these kinds caused a number of European States to come together between 1957 and 1961 to prepare and adopt the *Convention Internationale Pour la Protection des Obtentions Vegetales*, or the International Convention for the Protection of New Varieties of Plants (UPOV). The Convention was signed on December 2, 1961. It was revised on November 10, 1972, and on October 23, 1978. The Convention thus revised is referred to as "the 1978 Act". The Convention was further revised on March 19, 1991 and is referred to as "the 1991 Act." The reasons for the 1991 revision of the Convention were:

- to clarify certain provisions in the light of the experience of the UPOV member States in operating the Convention since 1961;
- to strengthen the protection offered to the breeder in certain specific ways;
- to reflect technological changes.

The main aim of the Convention is to promote the protection of the rights of the breeder in new plant varieties. The Convention not only requires the member States to provide protection for new varieties of plants, but also contains explicit and detailed rules on the conditions and arrangements for granting protection. It furthermore contains rules on the scope, the possible restrictions and exceptions, and the forfeiture of protection. It establishes, subject to certain limitations, the principle of national treatment for plant breeders from other member States; this means that in any member State nationals or residents of another member State enjoy the same treatment as nationals or residents of that State. Finally, it introduces a right of priority.

As of *August 6, 2001 UPOV had 49 member states*. Two-thirds of the UPOV member states are industrialized countries. Seventeen member states, none from the developing world, have so far ratified or accepted the 1991 Act. The main differences between plant variety protection under the UPOV 1978 Act and 1991 Act are as follow.

Provisions	**UPOV 1978 Act**	**UPOV 1991 Act**
Protection coverage	Plant varieties of as many species as possible; a minimum of five species on first accession and 24 after after 8 years	10 years after accession plant varieties of all genera and species; a minimum of 15 on first accession
Conditions for grant of protection	Novelty, distinctness, uniformity, stability	Novelty, distinctness, uniformity, stability
Protection term	Minimum years: 18 for trees and vines, 15 for other plants	Minimum years: 25 for trees and vines, 20 for other plants
Protection scope	Commercial production and sale or marketing of reproductive material of the variety	All production of and commerical transactions with reproductive material of the variety; the same acts with the harvested material of the variety produced by using infringing reproductive material but only if the breeder had no reasonable opportunity to exercise his right in relation to the reproductive material
Breeders exemption	Yes	Yes; if a variety is essentially derived from a protected variety, that is if it retains virtually the whole genetic structure of the protected variety, it cannot be commerically exploited without the consent of the breeder of the protected variety
Farmers privilege	The minimum scope of protection under the Convention only covered seed produced for the purpose of commercial	The minimum scope of protection covers all production. States are free to make an exception to permit the use

Box 3: Concerns of the Civil Society on the Impact of PVP in Developing Countries

One of the growing concerns raised by the civil society on intellectual property rights (IPRs) — particularly in the context of their impact on developing countries — are the consequences that legislation protecting such rights may have for food security and farmer's access to genetic resources. Concern has been raised — for example, by NGOs such as Genetic Resources Action International (GRAIN) that the international acceptance of common standards of PBRs — initially developed to meet the conditions in the advanced industrialized countries — may have the effect of undermining the food security of communities in developing countries. Among such groups, the current system of IPR protection for plants has generated three main causes of concern over its impact on food security.

1. **Encouraging the cultivation of a narrow range of genetically-uniform crops and worsening the nutritional value of people's diets.** The concern is that PBRs generally do not encourage breeders to investigate minor crops with small markets. This is because the returns on their research investment will be quite small. Moreover, protected varieties of plants may not even be food crops. In Kenya, for example, about half the protected new varieties are foreign-bred roses cultivated for export. In reality, many resource-poor farmers rely on minor food crops that enable them to meet the nutritional needs of rural communities much better than if major crops alone are cultivated. In the hills and valleys of Nepal, for example, villages may grow more than 150 crop species and plant varieties. It is possible, then, that PBRs may become responsible for a trend whereby traditional diverse agro-ecosystems, containing a wide range of traditional crop varieties, are replaced with monocultures of single agrochemical-dependent varieties, with the result that the range of nutritious foods available in local markets becomes narrower. Admittedly this trend is a global phenomenon whose beginning predates the introduction of PBRs. Nevertheless it is one that the existence and increasingly widespread use of PBRs has indirectly encouraged.
2. **Limiting the freedom of farmers to acquire seeds they wish to plant.** The second issue concerning food security is that in most developing countries, a large proportion of the population depends on agriculture for employment and income. Many of these farmers are small-holders for whom seed saving, across-the-fence exchange and replanting are common practices. This is especially true in countries — such as many of those in Africa — where neither the public nor private sectors play a significant role in producing or distributing seed. Although the UPOV system allows on-farm replanting, its rules restrict farmers' freedom to buy seed from sources other than the original breeders. In response, seed companies argue that farmers do not have to purchase PBR-protected seed just because it is available. They point out that the farmers are free to continue cultivating non PBR-protected seed — including traditional local varieties — if they so wish. Therefore their basic freedoms are unaffected by PBRs.
3. **Increasing the risks of disease outbreaks.** The third issue is the danger introduced by the fact that the UPOV rules require individual plant varieties to be genetically uniform. The problem is that the mass-cultivation of uniform varieties based on a narrow range of breeding material can result in outbreaks of devastating diseases. This happened with the potato crop in Ireland in the 1840s, and the United States in the 1960s and 1970s with wheat and maize respectively. It is often pointed out that many such disease outbreaks predate the introduction of PBRs to the affected countries. Despite this, critics argue that PBRs encourage the genetic uniformity that can potentially increase the dangers of such outbreaks occurring. Plant breeding companies, in response, argue that such concerns are exaggerated since outbreaks linked to widespread cultivation of PBR-protected varieties have not been common so far.

Adapted from Dutfield (2001)

Table 3: Costs to the society of implementing stricter IPR policies: Potential categories and empirical evidence

Cost categories	Empirical evidence
Direct costs **Drafting costs:** drafting new laws and adjusting current laws **Establishment costs:** National patent office, PVP office, new equipments, facilities **Administrative costs:** increased personnel to process and grant larger number of patent and PVP rights **Human resource development costs:** training patent examiners, judges, PVP officers, and administrative staff **Operating costs:** computer facilities, searching national and international repositories, publication of bulletins, upgrading examination and registration systems **Enforcement costs:** judiciary framework, court system, litigation and infringement law enforcement, customs enforcement	▪ Evidence from developing countries suggests that these costs could be substantive. Some examples include: [a] Chile: Drafting and human resource development costs estimated at \$718,000, annual and recurrent costs at \$837,000. Egypt: Personnel and equipment costs estimated at \$598,000. Bangladesh: Drafting costs to comply with TRIPS is estimated at \$250,000, and annual operational, enforcement and administrative costs at \$1.1 million ▪ There is wide disparity in the requirements for implementing stricter IPRs. The costs to a country will depend on specific circumstances of a country
Other costs to the society **Increased prices** of agricultural inputs **Increased time and money costs** in accessing research inputs by public research institutes	▪ Limited evidence from developed and developing countries suggests higher prices (though not excessively high) [b] ▪ More studies are needed to confirm the price effects of IPR ▪ Lack of evidence on the issue of time and money costs

[a] Source: UNCTAD (1996). The costs are not specific to the implementation of agriculture related IPRs.
[b] Examples include: Lesser (1994), Garcia (1998), Aquino (1998)

Table 4. Examples of Different Types of Market Segmentation

Criteria for segmentation	Example
Crop and region	1. The Monsanto and Kenyan Agricultural Research Institute agreement for a transgene for control of African sweet potato virus disease allows unrestricted use in sweet potatoes in Africa. 2. Insect resistant maize with proprietary technologies from Novartis is being transferred from CIMMYT to Africa but cannot be used outside of the region.
Variety	The transfer by Monsanto of genes for virus-resistant potato is restricted to selected varieties of potatoes predominantly grown by small farmers in the central part of Mexico.
Country income level	IRRI negotiated the rights for use of a stem borer resistance gene for rice from Plantech for all developing countries, as defined by the UN.
Trade status	In Southeast Asia the transfer of genes in Papaya provided by Zeneca for delayed ripening and for virus resistance by Monsanto is license free for production for the domestic market, with the rights to negotiate a commercial license for export production.

Source: Byerlee and Fischer (2001, p. 13)

Table 5. Area of IP Management in Need for External Assistance: Assessment of Survey Respondents from Public Research Institutes in Developing Countries

Area of IP management that needs external assistance	Percentage of respondents selecting a need area
Creating awareness and training researchers and administrators in IP policies and management issues	93
Research and marketing tools to estimate the market value of patents and protected varieties	93
Skills to negotiate research and license agreements/ material transfer agreements	89
Development of institutional IPR policies/guidelines/handbooks	74
Funds for accessing proprietary technology	74
Funds for filing and maintaining patents, PVP and other forms of IP protection globally	70
Establishment of an IP management office/ focal point	70

Source: Author's survey (2000). Total respondents = 27

Figure 1. Factors affecting the IP protection decisions of a public research institute: A decision framework