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Towards an Intellectual Property Clearinghouse for Ag-Biotechnology:

1. An Issues Paper

2. Summary of an Industry, Academia, and International Development Round Table

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Editorial Policy: The purpose of *IP Strategy Today* is to provide a forum to share creative, innovative and pragmatic analysis and ideas in intellectual property strategies and management issues, particularly as they affect the transfer of proprietary technologies to developing countries, developing countries access to proprietary technologies in agriculture, and the international exchange of genetic resources. Emphasis on the implications of biotechnology are specifically encouraged. Papers must have a problem solving orientation and demonstrate originality and innovation in thinking, analysis, methods or application. Issues related to research investments and management, bilateral and multilateral donor policies, extension, teaching, public-private partnerships are equally encouraged, as is interdisciplinary research with a significant IP and international development component. Manuscripts, review articles and working papers that offer a comprehensive and insightful survey of a relevant subject, consistent with the scope of *IP Strategy Today*, are welcome. All articles published, regardless of their nature, will be reviewed anonymously by members of the editorial board.

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Abstract

Much of the critique of patent systems for hindering research has focused on the scope or definition of what is patentable. We suggest, rather, that by focusing on the exchange of existing patent rights, significant improvements in freedom-to-operate can be achieved regardless of the state of patent reform.

Historically, in other industries, when IP congestion has threatened productivity, both government and industry groups have intervened, forming collective rights organizations such as patent pools and royalty clearinghouses that have provided freedom to operate with substantial savings for whole industries. Furthermore, today's advances in information technology have created new tools, *'IP informatics*' and *'online IP exchanges*', which provide interesting new organizational possibilities for collective intellectual property rights organizations.

The goal of an 'intellectual property clearinghouse' for agricultural biotechnologies would be to reduce transaction costs and other market failures that hinder the exchange of IP, creating pathways through the patent thicket and giving freedom-to-operate with proprietary biotechnologies. Such an institution has the potential to benefit all currently unsatisfied parties, in both the public and private sectors, in both the biotechnologically advanced industrial economies and in the biodiversity rich developing countries.

1. Botching a Delicate Balance

A fundamental economic tension exists between the public and private economic forces that drive agricultural biotechnology research. On the one hand, in the big picture of human welfare, our collective knowledge about agricultural science and genetics is a vital *common* resource for all of humanity (Herdt, 1999). On the other hand, the research that will advance our knowledge and our ability to wisely manage the earth's genetic resources depends upon *private* incentives of agricultural markets, which encourage companies to invest at levels unlikely ever able to be matched by public spending.

The granting of patents over the use of biological organisms, materials, and processes—in other words, intellectual property rights (IPRs) over the components of life—provides a very important practical compromise between the fundamental public and private economic forces that drive agricultural biotechnology research. The effectiveness of patents to perform this compromise, however, turns on two key factors:

1. the definition of what is patentable, to clearly demarcate between what should be claimable as private knowledge and what should be placed in the public domain of knowledge and open access genetic resources; and
2. the mechanism to exchange patent rights, to efficiently move privately-deeded knowledge into the hands of those users who are most able to create value with that knowledge and who, in so doing, can fairly compensate the private inventor of that knowledge or the steward of that genetic resource.

When the common (interdependent or complementary) aspects of agricultural knowledge and crop genomes are divided into multiple competing, overlapping, or mutually blocking private property claims, the value of the public economic benefits that would otherwise arise from these resources is diminished. Furthermore, if patent rights cannot be traded, the inventor-owners of these piecemealed resources will not be able to negotiate or purchase access to other patents needed to make use of their own inventions, in which case the power of the private incentives to innovate will be sapped. The cumulative result of such a crisis in research and innovation productivity has been quite aptly dubbed *'the tragedy of the anti-commons'* (Heller and Eisenberg, 1998)

Such concerns are nowhere more relevant than in agriculture (Enriquez and Goldberg, 2000), for as research in crop genetics, breeding, agronomy, pest control, agro-ecology, and related systems becomes more and more intertwined and complex, new agricultural research inevitably depends more and more on access to the proprietary knowledge and biological materials previously claimed by others. Indeed, in many cases, agricultural researchers' *'freedom-to-innovate'* depends on scores of patents. And while *'research only'* allowances may be granted for basic research in universities and public laboratories, the *'freedom-to-operate'* commercially for new agricultural products is usually immediately choked by a thicket of blocking patents (Shapiro, 2000).

The current *status quo* of this anti-commons climate benefits no one. Researchers in both public institutions and in private corporations—in both developed and developing countries—are finding their freedom-to-innovate and freedom-to-operate overly constrained. Legal costs and transaction costs for attempts to navigate through the patent thickets are mounting. Firms in agricultural biotechnology appear to have consolidated during the 1990s precisely to streamline access to patented technologies (Graff, Rausser, and Small, 2001). Uncertainty over blocking patents and freedom-to-operate has added additional burdens to the already challenging process of conducting international agricultural research and transferring agricultural technologies to developing countries (Wright, 2001). Both public sector institutions and private sector firms are spending valuable resources to solve intellectual property problems that could otherwise be used to guarantee the environmental and health safety of their innovations. The wave of consumer and environmentalist opposition to genetically modified foods, particularly in Europe, is spurred on at least in part by the perceived lack of access, transparency, and outside review that characterize the proprietary technologies that make these products possible. Economists studying this situation are concerned that economic growth, environmental health, and food security—all of which could benefit from advances in the biology of agriculture—are stalled and that the potential social, nutritional, and environmental benefits to the human race and the biosphere we live in are being squandered.

2. Unilateral Responses to the Intellectual Anti-Commons

On its own, a company has limited options to pursue its own freedom-to-operate within a congested IP landscape. Even universities and public sector research institutions are devising IP strategies to cope with the faltering IP compromise between public interests and private economic forces (Byerlee and Fisher, 2001; Kryder, Kowalski and Krattiger, 2000; Press and Washburn, 2000). Overall, the following IP management tactics constitute the potential unilateral strategies available to individual organizations, both public and private, that allow them freedom to innovate and operate:

- Invent around another's proprietary technology
- In-license another's proprietary technology
- Cross-license one's own proprietary technology for another's
- Strike a strategic collaboration or conditional access agreement
- Organizational integration with another IP holder.

3. Government and Industry-Led Collective Approaches to Solving the Anti-Commons

According to Robert Merges of the Boalt School of Law at U.C. Berkeley (Merges, 1996), theories on the economic nature of common-pool resources suggest that the roots of this problem cannot be effectively addressed through unilateral strategies; instead, some form of collective solution will be needed. Historically, public-policy collective measures taken to solve the problems of IP congestion include the following:

- Government exercise of intellectual 'eminent domain', purchasing key enabling technology patents and placing them in the public domain
- Government mandate of 'compulsory licensing' of patents for a fixed fee
- Government forced merger of firms holding mutually blocking IP.

Interestingly, however, private institutions or industry-led consortia have on occasion negotiated and organized effective actions themselves, without government mediation:

- Collective copyright enforcement of music compositions and recordings (e.g., ASCAP, BMI)
- Small, contract-based patent pools
- Industry-wide patent pools (e.g., Manufacturers Aircraft Association (MAA) formed in 1917, automobile industry patent pool in the 20s and 30s)
- Standard-setting patent pools (e.g., DVD technology).

Merges argues that such 'collective rights organizations' are more economically efficient than the government invoked solutions, especially compulsory licensing. Evidence shows that collective solutions have provided substantial savings for entire industries and for society at large. Despite the difficulties that must be surmounted in forming such a collective institution, time and again all players in an industry have seen it worthwhile to participate and conform to the rules and stipulations of the collective. However, horizontal collaboration through patent pools can provide a pretext for unhealthy degrees of collaboration and monopolization among the leaders in those industries, and given various abuses over the years, antitrust authorities view simple private patent pools with some suspicion (United States Department of Justice, 1995).

Despite these concerns, a strong case remains today for the formation of a multilateral collective rights organization to provide access to mutually complementary proprietary agricultural technologies and genetic resources. All currently unsatisfied parties—in both the public and private sectors, in both the biotechnologically advanced industrial economies and in the biodiversity rich developing countries—stand to benefit from some sort of *'intellectual property clearinghouse'*. Furthermore, there are several new options to consider in terms of the potential arrangements for such an institution, particularly as major trends in intellectual property information, management, and marketing are emerging with the advent of database and Internet technologies: tools such as *IP informatics* and *online intellectual property exchanges*. These tools provide new options for collective intellectual property rights organizations to work more like markets and less like cartels.

4. Intellectual Property Informatics for Agriculture

A first practical step toward solving the problem of the anti-commons is the broad provision of *'IP informatics',* to make information about a set of interdependent technologies and the IP that protects them broadly and freely available to all concerned parties. The common availability of information would help to overcome two serious barriers to fair trade in patented technologies: *'imperfect information'* and *'information asymmetry'*, situations where one or both parties in a transaction lack some of the information on which their decisions to buy or to sell rest. A complete and open flow of information helps individual researchers and organizations to identify actual and potential conflicts among patents already granted. When considering the potential savings and gains that may be achieved by providing such information to all organizations involved in agricultural research, IP informatics is a relatively inexpensive and straightforward investment.

The term 'IP informatics' was coined by the *Center for the Application of Molecular Biology in International Agriculture* (*CAMBIA*), a non-profit research institute located in Canberra, Australia, which offers the *CAMBIA Intellectual Property Resource,* an information service that is particularly suited to public sector researchers in international agricultural institutions and developing countries. *CAMBIA* provides, at minimal or no cost to the user, a readily searchable database of US, European, and international (PCT) agricultural and life science patents augmented by advisory and educational services. (See Table 1 for the web address of this and other IP information services).

While most national patent offices, such as the European Patent Office and the U.S. Patent and Trademark Office, provide web-based searches of their respective patent databases, these usually consist just of raw data or the texts of the patents themselves. More extensive supplementary patent information and analyses are sold by a variety of IP information services. The largest of these are the INPADOC databases of the European Patent Office, which cover patents in 65 countries, providing information on the current legal status of each patent and tracing the 'family' of patents issued in different countries for the same invention. The foremost private IP information service is *Derwent*, of *Thompson Scientific*, which maintains the *Derwent World Patents Index*, containing up-to-date patents from 40 different countries, summarized in English and classified according to *Derwent's* own comprehensive technology index. Other *Derwent* data products particularly valuable to agricultural scientists include the *Derwent Crop Protection File*, the *Derwent Crop Protection Registry*, the *GENESEQ database*, and the *Derwent Biotechnology Abstracts*.

Table 1: IP Information Sources

Name:	**Web address:**
Aurigin Systems	http://www.aurigin.com/
CAMBIA Intellectual Property Resource	http://www.cambiaIP.org/
CHI Research	http://www.chiresearch.com/
Delphion Intellectual Property Network	http://www.delphion.com/
Derwent	http://www.derwent.com/
European Patent Office, European Patent Register	http://register.epoline.org/espacenet/ep/en/srch-reg.htm
European Patent Office, INPADOC databases	http://www.european-patent-office.org/inpadoc/index.htm
MicroPatent	http://www.micropatent.com
Mogee Research & Analysis	http://www.mogee.com/
N.I.H. National Center for Biotechnology Information, GenBank database	http://www.ncbi.nlm.nih.gov/
U.S. Patent and Trademark Office	http://www.uspto.gov/patents/
U.S.D.A. Plant Variety Protection Office	http://www.ams.usda.gov:80/science/PVPO/pvp.htm
World Intellectual Property Organization Intellectual Property Digital Library*	http://ipdl.wipo.int/

* Includes hyperlinks to many national patent office databases.

An ideal IP informatics tool includes supporting data and analysis to add additional value to the use of basic patent data. This should include

- a database search methodology specifically structured and indexed to be user friendly and easily navigated by biologists and other non-IP professionals
- analytical tools to determine and display the IP landscape around particular patents, to characterize the differences and similarities among patented technologies, and indicate the positions of different organizations in the related technologies
- analytical tools to chart or interpret patents' legal claims to outline best approximations of the legal scope of patents.
- indicators of patent value.

Such analytical capacities are more costly to provide but are already developed and marketed by private IP data providers (such as *Derwent* or *Delphion*), IP management system vendors (such as *Aurigin Systems*), and IP consultancies (such as *Chi Research* or *Mogee Research*).

Beyond patents, other kinds of IP and technology data provide information resources important to agricultural researchers:

- Plant varieties protected by Plant Variety Protection Certificates (PVPCs) in the U.S. and by similar non-patent *'sui generis'* plant variety protection systems in other countries in accordance with UPOV.
- Seed bank or germplasm collections data (from the USDA, the CGIAR, etc.)
- Gene sequences and protein sequences claimed in patents (listed in *Derwent's* GENESEQ database)
- Publicly available genomic data on major crops and pests (some already listed in the N.I.H.'s GenBank database.)

Analogously, an informatics solution could be developed to help augment the flow of public and traditional agricultural knowledge and technologies, providing a centralized, user-friendly, and consistently indexed registry for non-proprietary, '*shareware*'-like agricultural techniques, especially sustainable agroecological, biocontrol, and integrated pest management methods that are not patented but published in articles, reports, or other research outlets. The timely publication and ready availability of technical disclosures assures that the technologies cannot later be patented. A forum for sharing such information could engender something like an 'open source' legal environment for many agricultural technologies.

In general, an IP informatics tool answers the initial question, *"Who has innovated or patented what?"* It allows technology users to identify and select a needed technology and then to decide upon appropriate IP management tactics, such as whether to invent around or to negotiate with a patent owner. However, such IP information and the expertise needed to use it effectively are not readily available to all agricultural research organizations. Larger corporations have already invested significant amounts subscribing to and installing some of these in-house IP information analysis and management systems and hiring intellectual property legal counsel.

In the final analysis, any IP informatics service functions to augment individual organizations' internal capacities to manage IP. It thereby informs organizations' unilateral strategies and occasionally promotes bilateral transactions. While the universal availability of IP informatics would be a necessary foundation for more market-oriented patent exchange mechanisms or multi-party collective rights organizations, IP informatics alone cannot solve the tragedy of the anti-commons.

5. Online Intellectual Property Exchanges

In a study at the Heinz School of Management of Carnegie Mellon University, Asish Arora and co-authors (Arora, Fosfuri, and Gambardella, 1999) explore the key benefits of markets for technology and the primary reasons that such markets fail to form. In light of their arguments, a fairly new and promising development aimed at solving the market failures caused by information failures and high transaction costs is the creation of '*online intellectual property exchanges*'.

Beginning in 1999, a number of entrepreneurial startup ventures emerged on the Internet with explicit business plans for creating virtual trading floors for intellectual assets. Online exchanges for intellectual property are inspired by the basic Internet business-to-business (B2B) model, and their promotional efforts tout the promises of free-market efficiency. The typical online IP exchange consists essentially of an embellished IP informatics service, or even more simply just a list of technologies, augmented by a few basic services to allow technology owners or technology 'shoppers' to initiate negotiations for a license. Some of the premier exchanges have designed more creative and comprehensive transaction-mediating and transaction-managing services. Many of them, however, amount to little more than online classified advertisements or a bulletin board of "patents wanted" or "patents for hire." Table 2 provides a current list of web-based IP exchanges.

Indeed, several serious concerns arise when considering the potential for patent exchanges to optimally redistribute technologies to those who can make the most valuable use of them for society at large. Exchanges are, in general terms, best suited for highly repetitive, routinized transactions of clearly defined, standardized, and readily priced assets, goods, or contracts, including contracts for services (Kaplan and Sawhney, 2000). Patents and licenses, however, do not often exhibit these qualities. The technologies specified in patents are highly heterogeneous, are often difficult to clearly or completely define, and may be impossible to evaluate sufficiently until well after considerable experimentation and refinement has taken place (i.e., well *after* the licensing transaction). Furthermore, innately held differences between sellers and buyers in their respective valuations of a technology may be wide enough to make it difficult to arrive at a clearing price for a license. These factors create uncertainties that darken the prospects for spot transactions of patents or licenses on an exchange.

Two relatively rare types of patents, however, do have qualities that should make them more conducive to online promotion. The first are those few patents that cover highly important general-purpose research methods, for which a winning marketing strategy would be to grant as many routine non-exclusive licenses as possible throughout the entire industry (which was the licensing strategy for the famous Cohen-Boyer patents of UC-San Francisco and Stanford). Holders of such general-purpose patents would benefit greatly from the low transaction costs of online promotion and distribution. Second, more numerous patents protecting highly specific and well-defined incremental improvements to familiar downstream products or processes could also be distributed online. These kinds of inventions are often most valuable when exclusively sold or licensed to the one specific potential user who values that innovation the most. Holders of these patents would benefit from the ease of finding and notifying a potential buyer and from the low transaction costs for executing a routine transaction. Finally, however, the bulk of patents that fall somewhere in between these two examples, either in terms of importance or in terms of generality of application, will likely be difficult assets to transact in the online exchange environment.

Online exchanges face other important difficulties. They currently are squeezed in an economic vice-clamp. On the one side, the business model depends upon attracting numerous buyers and sellers to make licensing transactions and then charging a small flat fee or a percentage commission on each transaction. Yet to achieve a sufficient volume of transactions, a site must maintain what may be called sufficient *'IP liquidity'*. IP liquidity is maintained not simply by listing a large overall number of available patents, but, more importantly, by listing a sufficient *'density'* of available patents within any given industry or field of technology, thereby providing potential customers with a sufficient selection to warrant their entering the site and searching for needed technologies. On the other side, the ability of online exchanges to maintain such liquidity is squeezed by intense competition. Startup costs for establishing a new website to host an exchange are quite low, and a large number of online patent exchanges now exists (see Table 2 on the next page), each scrapping for a relatively small proportion of the total market for patent licenses and each possessing only a very low density of patents in any given industry. The overall market is fractured, and most of the individual online licensing markets are currently too small to operate reasonably as exchanges.

In a specific field such as agriculture, no single online exchange provides access to all of the relevant intellectual property currently available. In particular, searching for listings of 'agricultural' or 'agricultural biotechnology' patents turns up spotty or empty results even on the most developed online exchanges. Indeed, surveying the many online exchanges is itself a significant search cost for an laboratory researcher or technology manager seeking access to a technology. Those in search of a specific kind of technology have to go site to site, registering numerous times for web site memberships, remembering passwords, and in some cases paying significant fees for membership or pay-per-view for patent listings in which they are not yet sure they are interested. Two things would help to alleviate this problem, at least for a given industry such as agriculture: 1) a drastic consolidation of the online patent exchanges into a unified marketplace or 2) a universal cross listing of current offerings across all of the online patent exchanges.

Consolidation or universal listings would, however, do little to circumvent the *'matchmaker's dilemma',* yet another problem to which the online patent exchange business model is susceptible. Once a potential buyer (or licensee) has discovered an interesting patent that has been listed by a seller (or licensor) on an exchange, the buyer-seller pair may find it more economically advantageous and secure to go offline and deal directly with one another, thus dispensing with the hapless matchmaker and avoiding a commissions payment. Much like a dating service, the patent exchange may excel in providing first-time introductions, but it is not

Table 2: Online IP Exchange Sites, as of July 2001

Name:	Web address:
Brain Supply	http://www.brainsupply.com/
Buy Patents	http://www.buypatents.com/
Delphion Intellectual Property Network	http://www.delphion.com/
Eurolicensing Global Technology Exchange	http://www.eurolicensing.com/
Intellectual Property Exchange (Price Waterhouse Coopers)	http://www.ipex.net/
Intellectual Property License Exchange	http://www.iplx.com/
International Invention Register	http://www.inventionregister.com/
IP Marketplace	http://www.ipmarketplace.com/
Knowledge Express	http://www.knowledgeexpress.com/
New Idea Trade	http://www.newideatrade.com/
Patent & License Exchange (pl-x)	http://www.pl-x.com/
Patent Auction	http://www.patentauction.com/
PATEX (by Corporate Intelligence)	http://www.patex.com/
Pharma Licensing	http://www.pharmalicensing.com/
Pharma Transfer	http://www.pharmatransfer.com/
Tech Tuesday	http://www.techtuesday.com/
TechEx	http://www.techex.com/
Thought Store	http://www.thoughtstore.com/
UK Technology Exchange	http://www.uktech.net/
Uventures	http://www.uventures.com/
Virtual Component Exchange (VCX)	http://www.vcx.org/
Yet2	http://www.yet2.com/
Zpatents	http://www.zpatents.com/

wanted to meddle further in a new technological relationship. The matchmaker dilemma threatens to constantly sap away the volume of technology-bearing, fee-paying traffic needed to maintain the IP liquidity of the market and the revenue base of the online exchange.

The value to society of more efficient technology markets—that is, more efficient mechanisms for getting good ideas deployed in their most valued applications—could be enormous. Where markets for technology are viable and competitive, the economic rule of efficiency calls for private enterprise to handle the creation of such markets. Public exchange services should be considered to support the formation of market mechanisms for IP and technologies only in those areas where wider social benefits can be anticipated and where it is unlikely that a private enterprise could support itself.

In the end, however, regardless of whether an IP exchange is privately or publicly backed, only those patents with characteristics that are amenable to the exchange mechanism will be made accessible. Other patents simply will not be distributed via this channel. Given the strategic (or monopoly power) value of many proprietary technologies, patent holders will likely decide not to offer them in an open market. In even these cases, however, it is possible that some type of mutually enforced agreement will offer holders of strategic patents a way to realize the value of their own patents while at the same time giving broader access to the protected technologies.

6. A Collective Rights Organization for Agriculture

We would like to propose that an intellectual property *'clearinghouse'* might be a most effective way to reduce market inefficiencies that hinder the exchange of privately deeded knowledge, allowing researchers to obtain the freedom-to-operate status necessary to commercialize agricultural research. Such a clearinghouse should be based on the basic principles of a 'collective rights organization' (Section 3) and utilize all available IP informatics (Section 4) and IP market exchanges tools (Section 5). In such a collective arrangement, multiple technology providers and users would be supported by a professional network and linked to one another through common contractual commitments. This would allow users to quickly identify relevant technologies and, through standardized licensing procedures, fulfill transactions of rights and technologies.

To be effective, a clearinghouse mechanism must provide the following three basic services:

1. The capacity to identify all relevant intellectual property claims over a given technology and, of those claims, to indicate which are and which are not available to be negotiated, and if they are, how they can be accessed
2. The establishment of a pricing scheme and terms of contract and a royalty disbursement accounting system
3. An arbitration mechanism for monitoring and enforcing contracts.

To serve as a collective rights organization for agriculture, such a clearinghouse should be specific to agriculture and the particular IP needs of researchers involved in agricultural research. While generalized IP informatics data sources and online IP exchanges (discussed above) do provide many valuable services, by maintaining broad coverage of many technologies, they sacrifice the necessary depth and comprehensiveness in a single field, such as agriculture. Moreover, the organization will need to be founded upon the trust and confidence of all its members, and its actions must maintain its members' confidence. A service created by and for agricultural researcher organizations certainly stands a much better chance of maintaining the trust and confidence of those in the field.

Indeed, an agricultural IP clearinghouse should be independent, neutral, and a catalyst for healthy competition in agricultural markets. If it were to be perceived as a technology user's club or a technology seller's marketing tool, its effectiveness would be diminished. The trust of prospective parties in the clearinghouse who were not in the favored core clientele would be eroded, and they would rightfully be reluctant to enter into transactions due to suspicions about unequal bargaining power. In addition, a collective organization that is not neutrally promoting competition in the industry would likely conflict with current regulations or case law pertaining to intellectual property licensing and antitrust (United States Department of Justice, 1995). Antitrust is a particular concern given the precedent of some e-commerce B2B exchanges for industrial supply commodities suspected of price manipulation and other antitrust violations (*The Economist*, 2000). The financial and governance structures of a collective rights organization must be both appropriately distributed among members and transparent to avoid any conflict-of-interest or collusion problems.

An agricultural IP clearinghouse would need to monitor patent validity, check and verify ownership status, and generally serve as a watchdog against problematic patents that are poorly written, overly broad, or otherwise disruptive to the productive flow of information and property rights in the industry.

In order to offer the collective rights efficiencies of a patent pool without the downfalls of pooling, an agricultural IP clearinghouse could *'bundle'* key combinations of interdependent or mutually complementary technologies together into patent *'micropools,'* each consisting of a set of interdependent or mutually complementary patents offered by the clearinghouse under a single contract. Numerous seperate micropools or bundles could be constructed and offered, providing access to different platform technology *'research toolboxes',* particular *'agronomic systems',* or specific *'plant systems'*. Furthermore, by actively pursuing flexible patent licensing strategies, it might be possible to customize bundled licensing products that could greatly increase the use of inventors' technologies (and thereby licensing revenues) as well as make multi-patent technology systems much more readily available and affordable.

Finally, an agbio IP clearinghouse would need to maintain and provide data about the current regulatory approval and biosafety status of new technologies in multiple countries. As the field of agricultural biology rapidly develops, it is crucial to keep track of which components of a technology system have been approved for which uses in which countries. Biosafety regulation is an important restriction on technological freedom-to-operate. It has a very strong influence on the value of a given patent or technology system and is crucial information for determining fair pricing and the terms of exchange for a technology.

7. Who Would Use an IP Clearinghouse for Agricultural Research?

Who are the most likely initial participants in an intellectual property collective rights organization or intellectual property exchange? Everyone involved in agricultural research is to some degree both a supplier and a user of new technologies. First, however, let us examine who is actively patenting biological applications for agricultural use. Here are the names of the top 30 assignees of agricultural biology patents in the United States at the end of 1998, with public sector institutions **highlighted** (Table 3 on the following page)**.**

Table 3: Patenting Organizations with Crop Biology* Patents

Patent assignee name	Number of agbio patents granted by the end of 1998
Pioneer Hi-Bred International (now owned by Du Pont)	238
Mycogen (now owned by Dow)	157
USDA Agricultural Research Service	**102**
Monsanto (now owned by Pharmacia)	66
Asgrow Seed (now owned by Monsanto/ Pharmacia)	64
Calgene (now owned by Monsanto/Pharmacia)	62
Zeneca (now Syngenta)	49
University of California	**48**
Holden's Foundation Seeds (now owned by Monsanto/Pharmacia)	47
Novartis (now Syngenta)	47
Du Pont	41
DNA Plant Technology (now owned by Savia)	38
Ciba-Geigy (now Syngenta)	36
Plant Genetic Systems (now owned by Aventis)	36
Cornell University	**33**
DeKalb (now owned by Monsanto/Pharmacia)	33
Iowa State University	**29**
Sandoz (now Syngenta)	26
University of Wisconsin	**24**
Hoechst (now Aventis)	23
Lubrizol	22
Ecogen	19
Rhone-Poulenc (now Aventis)	18
W. R. Grace	18
Texas A&M University	**17**
Michigan State University	**16**
North Carolina State University	**16**
Agracetus (now owned by Monsanto/Pharmacia)	15
Imperial Chemical Industries (now Syngenta)	15
Research Corporation Technologies	**15**

* Patent counts include utility patents over enabling biotechnologies, genes, and germplasm, including plant varieties, hybrid lines, etc.

Source: Gregory Graff, dissertation, Dept. of Agricultural and Resource Economics, U.C. Berkeley, forthcoming 2001.

8. An IP Clearinghouse and Technology Transfer to Developing Countries

Equally important questions to ask are the following: *"Who is not in the game?"*; *"Who is in danger of being locked out of the dynamic advance of agricultural technologies?"*; or *"Who is not investing in research because of uncertainties surrounding the validity and enforcement of IP?"* These include:

- Farmers, growers;
- Agricultural co-ops and grower's associations;
- Many of the land grant and public universities in the U.S. and abroad;
- International agricultural research centers of the CGIAR;

- National agricultural research services (NARS) of developing countries;
- Medium and small-scale seed enterprises and nurseries in developed countries; national seed companies of developing countries;
- Agricultural development NGOs.

One of the most important things to consider in exploring options for an intellectual property clearinghouse is that the newly available IP informatics and market-based tools could not just allow but actually encourage the participation of those currently left out of the game. Not only would today's outsiders find themselves able to in-license currently unavailable technologies at reasonable costs and on reasonable terms, but they would be encouraged to develop and out-license their own inventions for fair returns on reasonable terms. Incentives would be aligned to encourage the development of agricultural research capacity. Similarly, other potential technology providers (farmers, coops, university professors, independent inventors, small firms) who currently have the capacity but lack the incentives to undertake certain lines of research for themselves, would come to see the advantage of completing and patenting undeveloped ideas that they could offer to others in an active and healthy technology marketplace.

A number of voices have recently been advocating collective IP solutions for public-sector and international agricultural research, seeking in the relatively short term to obtain freedom-to-operate for academic and not-for-profit international agricultural research institutions through some sort of licensing mediation or IP pooling mechanism (Bennett, 2000; Prakash, 2000). Similar calls have been heard in the related fields of medical biotechnology and genomics (Shulman, 2000.) A meeting of agricultural intellectual property stakeholders during the World Food Prize Symposium in Iowa in October 2000 sought dialogue about the variety of institutional needs and possibilities (Prakash, Ives, and Comstock, 2000).

It emerged from these discussions that a first credible step toward creating an IP clearinghouse might be to erect a mechanism for the bundling and provision of inexpensive '*humanitarian use licenses'* for the release of new developments from agricultural research dedicated to solving problems of food security, malnutrition, and poverty. GoldenRice, the variety engineered to deliver pro-vitamin A, is the first in what could be a long list of potentially useful technologies developed by public sector researchers, but which need permission from multiple private and public sector patent holders in order to be released and sold in most of the countries where it is needed (Kryder, Kowalski, and Krattiger, 2000). A separate set of multi-party IP agreements could be hammered out each time a new variety comes along, an arrangement that may slowly choke off public sector involvement in such work. Or an established clearinghouse could build expertise in negotiating such IP agreements and build upon previous agreements.

The utility of a clearinghouse beyond its role in the coordination of IP philanthropy would quickly become clear. The academic and corporate donors of the humanitarian use contracts might soon approach the clearinghouse with requests to help negotiate complex arrangements for their own needs, for example, to provide freedom-to-operate for a previously neglected crop that only university-based plant breeders were working on, or for an environmentally beneficial trait whose low expected profit level previously could not justify the costly bilateral licensing negotiations necessary to launch it as a commercial product.

9. Conclusion

As a collective rights organization utilizing the available tools of the IP informatics service and the online IP exchange, a proactive, industry-specific IP clearinghouse could level the playing field and free up agricultural research by creating paths through the growing thickets of competing intellectual property claims. A clearinghouse might also help to reverse consolidation in the industry, since it would no longer be necessary to control in-house a complete portfolio of interdependent complementary technologies to maximize value from any single component technology. It could free companies from the innovation-constricting technological platforms to which their in-house patent portfolios currently limit them. It could help to move appropriate technologies out into regional and applied agricultural research systems around the world, providing incentives and means for current outside players to strengthen their agricultural research capacities. Finally, an IP clearinghouse could help agricultural research achieve and maintain a healthy, dynamic balance between the public and private forces that are now haphazardly shaping its future. A clearinghouse will help us to rationally direct these energies more efficiently, more safely, and to the benefit of all.

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Intellectual Property Clearinghouse Mechanisms for Agriculture:

Summary of an Industry, Academia, and International Development Round Table [1]

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Conclusions and Recommendations from the Round Table

General conclusions:

1. Developing and applying appropriate biotechnologies has potential to mitigate food security problems, improve food quality, and address environmental issues, but, as with any new technology, there are numerous drawbacks and risks, such that significantly more and better research is needed to realize the potential benefits.
2. The three main obstacles to further research, development, and application of appropriate and beneficial biotechnologies are overly restricted access to intellectual property, consumers' lack of acceptance, and uncertain government regulation.
3. If mechanisms were implemented to reduce costs associated with transacting intellectual property rights (IPRs), the breadth and quality of applications made with currently existing technologies would increase to better serve the interests of customers and the general benefit of society.
4. Public sector and university researchers have a relative advantage in coming up with new basic technologies. Private companies are most capable in the development and introduction of products to market. Thus, the need for efficient technology transfer is inherent in the agricultural research community.
5. The alignment of profit incentives and R&D costs of new products (partly due to high IP transaction costs) leads to the neglect of large segments of agriculture, most notably minor crops and large parts of developing world agriculture. Neither private incentives nor publicly funded mandates suffice to meet the R&D needs in these sectors.

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[1] On February 16, 2001, UC Berkeley's Center of Sustainable Resource Development (CSRD) and the UC Office of Technology Transfer hosted a meeting at the Bancroft Hotel in Berkeley. The goals of the meeting were to address the perceived underdevelopment and underutilization of new agricultural technologies and to consider solutions to the continuing concern of researchers at universities and public sector research institutions—in both the United States and developing countries—about their limited capacity to access and commercialize new technologies because of intellectual property (IP) considerations. Over 90 participants attended from a variety of universities, companies, and US government agencies.

The meeting was made possible by generous financial support from the Giannini Foundation, the Farm Foundation, the Rockefeller Foundation, and the University of California Division of Agriculture and Natural Resources (DANR).

6. IPR interactions within and between the university, the public research sector, and the commercial sector in the developed countries are plagued with transaction costs, primarily because of broadly or poorly defined claims in individual patents and because products involve technologies claimed by multiple IPR holders.

7. IPR interactions involving the international agricultural research community are plagued with transaction costs primarily because of confusion over the proliferation of nascent IP policies in many countries, insufficient policy coordination, and the lack of education and experience among researchers and administrators in dealing with the international dimension of patent issues.

8. IPR trading works best when it occurs between parties of similar size that are simultaneously both buyers and sellers of IPRs. Under such conditions there is less emphasis on rent-seeking behavior.

Recommendations for Cooperation to Meet the Needs Identified in the Round Table:

1. There is a potential role for 'IP aggregators' in two kinds of cases:

a. When many small parties are involved, the aggregation of their IP interests, providing quick and easy access to technology licensing markets, would reduce transaction costs.

b. When mutually interdependent patents over a common technology system are scattered over multiple parties, it would be generally beneficial to gather the relevant patents together and make them accessible together on reasonable licensing terms, reducing the transaction costs of 'shopping around' for the pieces of that technology system and increasing the volume of out-licensing sales for the holders of those complementary technology components.

2. Two sectors in particular--R&D for horticultural crops and agricultural R&D for developing countries--have similar needs for IP aggregation functions.

3. All R&D sectors of the agricultural economy need better information and better access to technologies. All would be well served by mechanisms that reduce IPR-induced transaction costs by:
   a. Identifying who has which rights to which technologies
   b. Conducting objective valuations of IPRs and designing compensation schemes
   c. Standardizing processes to obtain licenses
   d. Managing flows of royalty payments
   e. Enforcing contracts

4. Education in IP practical policy and legal issues should be emphasized in developing countries in order that they may know
   a. When and where IPRs are a real constraint
   b. How to design their own IPR policies for their own needs and circumstances
   c. How to obtain favorable conditions for using existing technologies

5. Institutional arrangements, such as clearinghouse mechanisms, that modify the current effects or values of IPRs should be judged relative to their impact on the overall performance of agricultural and food systems rather than their impact on individual parties or interest groups within the system, be they consumers, farmers, inventors, or companies. This will require a fundamental degree of trust and confidence among the various parties or groups that over time each will become better off or at least no worse off as a net result of such measures.

6. Integrate IPR policies with efforts to:
   a. Remove international barriers to trade
   b. Formulate national and international biosafety regulations
      (including approval and registration processes)
   c. Enforce antitrust in agricultural and food systems.

Introduction

Dr. **Richard Malkin**, Dean of the College of Natural Resources and a professor of plant and microbial biology at UC Berkeley, opened the meeting by welcoming the participants and emphasizing the crucial nature of intellectual property (IP) issues, particularly in the context of recent furor raised over the completions of both the human genome sequence and the *arabadopsis* genome sequence. Dr. **David Zilberman**, Director of the CSRD and professor of agricultural and resource economics at UC Berkeley, explained that this meeting was organized because the current situation in the agricultural biotechnology industry seems ripe for a discussion of mechanisms to reduce transaction costs and to remove excessive barriers to using proprietary technologies. The general goal of the round table is to discover and to share in a public forum the possibilities for co-operation, exchange of knowledge, and transfer of technologies that have at least the potential to benefit all humankind.

Session 1: Intellectual Property's Effects on Research, Innovation, and Adoption of Biotechnologies for Agriculture

According to Dr. **John Barton**, professor at the Stanford University School of Law, the scope of property rights established by patents today depends not so much on the scientific results of the inventors as it does on the imagination and skills of the lawyers who draw up the patents and the rules and guidelines under which the patent examiners work. While the criteria used in granting patents continue to be 'novelty', 'utility', and 'reduction to practice', the interpretation of these criteria may vary, sometimes being too strict, sometimes too lenient. When too many patents are issued over a given area of technologies, researchers may lose their flexibility or freedom to operate, resulting in increased research costs and decreased discovery rates, primarily because of the need to coordinate rights to use technologies covered by an excessive numbers of disparate patents. One upshot of this, particularly in the case of agricultural biotechnology, is to question the patenting of genes, for which discovery has by now become routine and hardly a 'novel' methodology.

Professor Barton also emphasized that patents are defined within the distinct jurisdictions of individual nations or, as in the European Union, within a specific group of nations. He suggested the introduction of global patents to reduce registration and transaction costs across jurisdictions. He also suggested that, given the present situation, researchers in developing countries need not be overly concerned to obtain licenses for technologies patented, for example, in the United States for products that are unlikely to be exported to the United States. Furthermore, while the World Trade Organization (WTO) agreement on trade-related aspects of intellectual property rights (TRIPS) requires every member country to have an IPR system for plant varieties, many developing countries may be better off introducing a plant breeders' rights system rather than issuing utility patents over plant varieties. Professor Barton suggests that excessive litigation involving patents, the high cost of obtaining rights of use, and simple lack of knowledge about patent law can lead individuals and organizations to be too conservative in their use of proprietary technologies. They may significantly underutilize agricultural biotechnology and consequently place unnecessary restrictions on agricultural research. Both the streamlining of international IPR agreements and more rigorous standards for granting patents would help to remedy this situation.

Dr. **C.S. Prakash**, Director of the Center for Plant Biotechnology Research and professor of plant molecular biology at Tuskegee University, outlined the successes of the Green Revolution in alleviating hunger and pointed out how new technology has been crucial for developing countries. Noting estimated future population increases in developing countries and the fact that increasing yields due to Green Revolution technologies have plateaued, he argued that for continued success new technological advances for developing countries must be found in molecular biological and genetic technologies. While citing the great potential for applying biotechnologies in the agriculture of developing countries, he pointed out several basic problems that need to be overcome to make it a reality. These include the lack of capacity in developing countries for R&D in the molecular biology of agricultural crops and systems, the lack of access to proprietary technologies for those few who do have such capacities, and the general underinvestment or disinclination of major agricultural technology companies toward the most needy sectors of developing country agriculture.

Dr. **Brian Wright**, professor of agricultural and resource economics at UC Berkeley, similarly emphasized that pre-biotech agricultural research was a remarkably productive public sector enterprise with sustained yield increases and very high rates of return long before patents were important. He pointed out that one of the strengths of the public agricultural research system was free access to most inputs, including germplasm, and the free transfer of information. Furthermore, he argued that the claim that in the US only the private sector does effective research is not only historically false but is also contradicted by the fact that companies' expertise is focused almost entirely on major crops.

Interaction between stronger IPR and biotechnologies drove recent developments in agricultural research: biotechnologies made patents more enforceable and enforceable patents made biotechnologies more profitable. Under stronger patent protection, research tools spilled over from medical biology, and new startup companies and existing agricultural input firms entered into plant breeding, working mostly, however, on trait development for the few most profitable crops. The WTO TRIPS agreement held out trade access as a carrot to developing countries eager to join in the biotech revolution, requiring them to provide intellectual property protection and encouraging the international proliferation of strong biotech IPRs.

The first round of agbiotech was approached enthusiastically, leading to the development of research tools, input substituting traits, and output traits. The first round of any change like this, in general, provides the best possible incentives for private sector entry: the field was wide open, with few IP claims and most of the technology in the public sector. However, in the second round, for those who want to do further research, there is now a field of multiple prior IP claims that have to be worked around, creating a situation called "the tragedy of the anti-commons" (Heller and Eisenberg, 1998). Third and fourth rounds will only get worse because patenting rates are increasing exponentially and because agricultural technologies are unusually cumulative in nature, involving complicated packages of multiple technologies that embody many prior IP claims. For example, vitamin A-enhanced rice utilized technologies are said to be protected by up to 45 patents in some parts of the world.

The high transaction costs involved in licensing result from the uncertainty, excessive breadth, and conflicting claims of patents, the difficulty of identifying valid licensors, the cost and slow pace of litigation, and concern over liability, brand image, and externality control. Transaction costs lead to hold up problems. In a number of cases technology holders have simply been unwilling to negotiate with potential technology users, not questioning *what* price, but rather being unwilling to discuss *any* price. Some recent examples of hold ups include the following:

- University of California—long shelf life tomato
- Michigan State University—herbicide resistant turf grass
- CLIMA (Australia)—herbicide tolerant lupin.

Each of these cases involves a different patent holder and can be understood on the grounds that negotiation is costly and licensing can lead to unintended problems of reputation or goodwill.

A solution in the private sector to high licensing transaction costs has been consolidation. A parallel is found in the history of commodity trading, which once involved many firms in open and fairly competitive markets that utilized financial derivatives such as options and future contracts. In a bout of anti-gambling sentiment such derivatives were outlawed and the industry became vertically integrated, with only four or five major commodity traders now in the world. Without being able to do arms-length exchanges, the solution was to consolidate to reduce transaction costs.

Public sector institutions face especially severe problems in handling licensing transaction costs. First, it is difficult to arrange incentives for public sector scientists, who are typically allotted a third of their patent's licensing revenues, to willingly contribute their patents to patent pools that do not account for the value of the individual patent. Public sector institutions suffer from inexperience and lack of expertise in the management of complex dynamic IP portfolios. Consolidating organizations in the public sector is not feasible. Furthermore, public sector institutions concentrate on unprofitable crop markets.

The purpose of this conference is to discuss how to make transactions less costly and to make more feasible the kinds of arms-length licensing deals that heretofore are failing. This will not be an easy project, but we should be in the business of getting things done, not getting things done perfectly. There will continue to be market failures, regardless, because patents are not the only source of market failure. Some complications to keep in mind are the simple lack of trust between parties that prevents them from sharing IP protected technologies and engaging in potentially valuable collaborative work, as well as the high uncertainty that plagues the current condition of the patent system, particularly in terms of knowing who owns what technology.

Still, the prospects for an IP clearinghouse are interesting. It will work better at solving transaction problems with technologies that are more standard and universally known. Some day it may be as easy to license and use one of these patented technologies as it is to play a copyrighted song on a radio show. For more heterogeneous technologies, a ‘dating service’ may serve a crucial informational role, allowing researchers and companies to know what is out there and who has it, particularly as the number of patents in the field grows rapidly. Finally, patent insurance has some interesting but yet untested promises that need to be explored.

Session 2: Principles and Tools for IP Clearing

The second session of the round table concentrated on general tools, principles, and experience from other industries relevant to the processes of identifying, accessing, and trading intellectual properties. Dr. **Richard Gilbert**, professor of economics at UC Berkeley, provided lessons in international property rights, cross licensing, and pooling and gave examples from the semiconductors industry. In spite of the complexity and interdependency among firms in the semiconductor industry, he pointed out that the industry has thrived and IPR disputes do not play a major role in the industry today. Relying on results of the new theory of industrial organization, Professor Gilbert explained that industries in which IPRs are owned by multiple entities—with each entity needing to execute transactions for permissions to use others’ technologies to generate their own final product—have to take into account the stacking of royalty payments. He compared this with a toll bridge on which a collection booth is located every 100 meters along the bridge. Stacked royalties can add up to a considerable sum and may raise the price of the final product above its optimal market level. Furthermore, the execution and management of transactions may be cumbersome and may push IP transaction costs as well into the price of the final products, making them too costly, under produced, and under utilized, thus leading to a sub-optimal resource allocation in the economy.

In the case of the semiconductors industry, the main players consist of several firms that are simultaneously both providers and users of IPRs. These companies are interested in profiting from their overall product line rather than from their individual patents. They thus establish patent-swapping arrangements (i.e., cross-licensing alliances within which each partner shares its patents with the other, within limits, in exchange for access to their patents). Professor Gilbert suggested that product development goes beyond patent development, design, production, marketing, etc. such that IPR is only one component of a larger set of decisions and generally does not make up the lion’s share of either the value or the costs of production. When technologies are shared and technological knowledge is available, firms use their resources to concentrate on other more expensive and demanding aspects of production.

One problem with patent swapping in an oligopoly structure is the possibility that industries become too stagnant: new entrants may be constrained in their capacity to introduce new products. Another problem arises when parties are not actually swapping, i.e. simultaneously in-licensing and out-licensing patents. Smaller, one-sided technology providers who are not active technology users, such as small companies, individuals, or even university faculty, are more likely to hold up the market in seeking to receive full monopoly rents on their patent. (Although they may be partly motivated by the real concern that large companies, as sole buyers, can force them to surrender their intellectual property on unfavorable terms.) Professor Gilbert provided some examples, however, where owners of critical and unique patents, that were nonetheless dependent on other existing patents, were able to establish companies and enter the industry. Swapping patent rights (cross licensing) does not exclude paying patent royalties to new upstart companies or owners of unique patent rights. In medical biotechnology and in chemistry, independent startups are actively introducing new technologies, and the owners of the rights to these new technologies are able to obtain significant royalties. They are often absorbed after a while by one of the existing corporations, which incorporates the technology in its own arsenal and uses it either to trade for rights or to exclusively develop products.

Mr. Irving **Rappaport**, vice-president of *Aurigin Systems, Inc*., in Cupertino, California, presented a computer software and online data access system called the Aureka Workbench, designed to handle large, complex, and fast-growing patent information databases. This software identifies subsets of related patents by subject matter, arranges thematically related patents in a topographical format, and can break them out chronologically. In general this software tool enables those addressing specific problems in generating technologies to identify patents that are relevant to their specific field of work. Furthermore, since this software develops maps of existing patents based on their technological content, it is able to identify technological gaps as well as patterns of potential complementarity and substitution among patents. These database tools can also select and sort patents by assignee (organization of original ownership). Officers of technology transfer and IPR managers can use the Aureka system to seek out which parties they need to approach for licenses or to identify potential partners for cross licensing. It also provides an understanding of individual organizations’ areas of strength and weakness and thus assists in establishing research collaboration or cross-licensing exchanges of IPR.

Dr. **Nir Kossovsky**, MD, founder and CEO of *The Patent and License Exchange, Inc*., ("pl-x.com") in Pasadena, California, presented an interesting set of software tools and web based services for the valuation and exchange of technologies. The exchange or clearinghouse aspect of the Patent and License Exchange provides several services to traders of IPR. It brings together buyers and sellers, provides guidelines and assistance in establishing prices, insures patent validity, and helps execute trades.

Dr. Kossovsky suggested that by using some of the most advanced tools of finance one could assess the value of patents. He views patent rights as options that may or may not be exercised by the owners at any given point in time. Dr. Kossovsky's system adapts the Black and Scholes formula from the world of finance to estimate the value of a patent, at the least to create a starting point for negotiations of a patent's value to interested parties. The value of such a 'patent-option' is uncertain and is based on both the success of the technology and market conditions. Thus, in developing these valuations, the owner of the patent needs to provide information about the patent's expected benefits and a measure of the uncertainty regarding its success, both of which are difficult but not impossible to provide in some form. For example, suppose developers of a patented technology or their representatives expect that seven years after a patent is introduced it will generate, on average, $1 million per year in revenues. There is, however, a non-negligible probability that there will be zero returns, as well as a significant probability that there will be returns greater than $2 million. Of course, different conditions for patent use and the degree of owner exclusivity may strongly influence the value; accordingly, this software allows for calculations under various assumptions. At the very least, the valuation calculation provides the interested parties with a starting point from which they can then begin to negotiate.

The Patent and License Exchange provides a variety of other services intended to promote more efficient exchange of intellectual properties. Search algorithms are specially designed to help those parties seeking specific technologies and those providing specific technologies to find each other's entries in the database, something like a 'patent dating service'. . For example, the search algorithms can accommodate different units of measurement, synonyms of search terms, and conditions such as prices 'greater than' or 'less than' a certain value. Other pl-x services include a secure transaction environment and an arrangement with Swiss Re to provide 'patent validity' insurance of up to $10 million toward the event that a patent licensed through the exchange turns out not to be valid in court.

The intended functions of The Patent and License Exchange are clear and straightforward: to increase available information about the market, to reduce the information symmetry between buyers and sellers, to decrease search costs, to provide some kind of objective measure of patent value that will increase the speed and efficiency of negotiations (if simply by serving as a recommended starting point for price negotiation, much like the Blue Book recommends a price level for a used car), and to manage the uncertainty and risk of intellectual property licensing transactions.

Considerations from Session 2

Several important considerations arose in response to these three speakers. We expect that organizations with significant endowments of intellectual property (i.e., that already have an 'in-house' pool of IP over biotechnologies or germplasm) still need access to additional complementary IP and would be interested in some kind of swapping. These include major agricultural biotechnology-producing companies, universities in the United States and Europe, and research centers in developing countries. It is very unlikely that there could or should be a comprehensive pool with completely open swapping of agricultural biotechnology and plant variety IPRs; rather pooling or cross-licensing arrangements will most likely be partial or segmented, based on specific conditions. For example, universities may agree to swap research and commercialization rights only amongst themselves and, in addition, may agree to swap the rights to subsets of university technologies with corporations in exchange for access to subsets of their technologies. Thus, it is beneficial to combine individual organizational pools with intellectual property pools that already sell rights but also need other rights.

A number of information technology and data management tools are already available to deal with the complexity of biological and IP information. The information and software technologies presented in this round table provide examples of the vast array of new developments for the identification, analysis and comparison of technological and legal content and for economic value estimations of both individual patents and entire sets of patents. These tools make it more and more possible to evaluate and commodify the elements of complex technology systems. They also provide an infrastructure that can manage the execution and accounting of actual trades of IPR. These technologies are essential for technology providers and users scale up the exchange of IPR. Some of the historical challenges that have been associated with the excessive costs and demands of trading IPRs can be significantly reduced. Still, these tools will not be able to systematize away all of the complexity. Lawyers and biologists will still have to apply their professional knowledge and negotiate creatively.

The design of a clearinghouse depends on the specific situation that it addresses and the needs of the various users, drawing on the number of potentially available tools and mechanisms. In some cases, a clearinghouse can play the simple role of matchmaker, where parties then go off on their own to negotiate and perhaps execute a transaction. Even such a simple clearinghouse may help to establish a price for technologies, at least as a starting point for negotiations.

Even with these tools in hand, when there is high uncertainty and complexity in a new field of technology, valuation will be difficult. Often technology providers and users will have significant disagreements over the methodology used to evaluate the IPR—and sometimes even over basic understandings of the features of the IPR or the particulars of the technology.

Session 3: Visions of an IP Clearinghouse for Agriculture

The third session of the round table focused on the prospects for an IP clearinghouse specific to the needs of agriculture. Mr. **David Kryder** from the International Service for the Acquisition of Agri-biotech Applications (ISAAA) at Cornell University opened this session with a dramatic demonstration of the need for building confidence and trust in order to accomplish a goal under uncertain conditions: he walked blindfolded up to the podium with only the guidance of verbal instructions from **Gregory Graff**, but first he had to gain confidence in and establish trust in his guide, which he did so by asking a series of questions. These demonstrated qualities of confidence and trust, he argued, are the key requirements for any arrangement to promote cooperation between individual technology stakeholders and the exchange of technologies , both in developed and developing countries. He described 'confidence' as an initial assessment of another's capability to perform and 'trust' as earned over time by consistently performing as promised and expected. He believes that a major obstacle to current knowledge exchange or sharing of IPR is precisely the lack of trust resulting from previous bad experiences.

Mr. Kryder described the work of ISAAA as an honest broker of technology transfers in projects in Africa designed to increase the yield of bananas, to create virus resistant sweet potatoes, and to develop multi-use forest products, and in Southeast Asia to develop virus resistant papaya. He pointed out that often a technology donor and technology recipient may not trust one another, even if they are confident in the technology. However, they both trust ISAAA, and, based on that trust, they can enter into a legal and moral agreement and make the project successful.

What could an IP clearinghouse do to develop confidence and trust? Above all, it could develop a clear understanding of what the parties need and want. Potential recipients and donors need to lay these out on the table so they can be addressed. If the real goal of corporate owners is to market developments in the non-industrial world, then that should be said. If universities want to increase the sales of technologies that they cannot move, while still serving the needs of society, then that should be said. If some want a poster child to tell the world that genetically modified organisms (GMOs) are safe and nutritious, then that should be said. Clearly stating what is needed and wanted by all potential partners is essential to building confidence and trust. Many of us would like to see an IP clearinghouse created. We want it to work and to be successful. We do not want it to become a repository for junk technologies that cannot be unloaded anywhere else, and we do not want it to make false promises that we cannot be confident will be fulfilled.

There have been nascent attempts to collaborate and share IPRs in the public sector according to **Alan Bennett**, a professor of crop science at UC Davis and the executive director of the University of California Office of Technology Transfer. Dr. Bennett described the traditional roles of the land grant universities and the Agricultural Experiment Stations as including conservation of crop genetic resources, crop-breeding activities that provide finished cultivars to the local agricultural industry, and the creation of fundamental innovations. Many key enabling agbiotechnologies have their foundations in university research, but much of that was transferred to the private sector and has become an impediment to further university research.

Dr. Bennett pointed out that there have been very few applications of modern biotechnology to specialty crops, especially fruits and vegetables. A few early projects funded by industry groups in California (one in walnuts, one in strawberries) were abandoned primarily because the university's access to enabling technologies was restricted. The university had the germplasm and the genes, but lacked permission to commercialize based on the transformation technologies and promoters used in the work. Other problems, of course, included regulatory issues and public acceptance.

There have been a number of missed opportunities in agbiotech, including the following:

- Low value crops have not been addressed.
- Low value traits (such as human nutrition) have had little attention.
- Traits targeted to subsistence farmers have not been developed.
- The expertise of public-sector breeders is not included in developing agbiotech crops.

The community of crop researchers at land grant universities and agricultural experiment stations has been discussing for some time possible paths to a publicly accessible toolbox for plant genetic transformation. This would allow public researchers to continue their traditional role of addressing the needs of orphan crops and the development of traits with low commercial but high social value. This would also decrease barriers to commercial development of transgenic horticultural crops. The technological components of such a toolbox would include a base of enabling technologies with transformation methods, selectable markers, and promoters, and a set of genes that provide particularly interesting traits.

A proposal titled "Functional Genomics of Horticultural Crops: a National Transformation Consortium" was developed by six land grant universities with the primary goal of combining IP portfolios into a patent pool that could be drawn from in a more uniform fashion. For example, the University of California has a portfolio of 125 agbiotech patents. Only 25 of them are exclusively committed to commercial partners and are thus unavailable. The remaining 100 remain unlicensed, not because they are all useless, but because many require outside complementary technologies to create a value that goes beyond the single technology. The university wants to find strategies to make these technologies available to the public, either commercially or otherwise.

The first major component of the proposal included four primary objectives:

1. The development of an annotated database for researchers that identified what patented technologies were available from the pool and on what terms
2. The management of a repository for enabling technology materials to be distributed to researchers.
3. The negotiation and administration of material transfer agreements (MTAs) for resources not in the public domain.
4. The provision of advice to university researchers to optimize both their experimental objectives and their subsequent freedom to operate with plants or technologies they developed.

The second major component of the proposal was to create a national network of 'transformation service and training centers' at the universities that would specialize in providing genetic transformation services in horticultural crops, public education, and research on new transformation technologies to invent around proprietary methods now unavailable to the universities. There are extensive public resources available but there has not been an organized effort to pull these together and make them of practical value.

Similar ideas are currently being explored with other institutions. The University of California is developing a partnership with the Max Plank institute to compare the two institution's IP portfolios, to bundle and license particular patents that would be of greater value when packaged together, and to pursue cooperative research to further exploit these synergies.

Dr. **Catherine Ives**, director of the Agricultural Biotechnology Support Program at Michigan State University, began with the premise that biotechnology has the potential to alleviate food problems in developing countries. She emphasized that cooperation between universities in the United States and research institutes in the developing world to design technologies that increase productivity and reduce crop diseases will significantly benefit the poor. Major companies may underemphasize products for poor farmers' because of their obviously limited ability to purchase genetically enhanced seed and farm inputs. Thus, alternative organizations will be responsible for developing appropriate technologies.

Dr. Ives emphasized the need for researchers in developing countries to obtain rights to IPRs and also the importance of mechanisms to transfer essential enabling and process innovations. Access entails not only the rights represented by patents but also supporting information, proprietary databases, and critical know how. It is important that appropriate mechanisms be developed so that scientists in developing countries know when technology is available and how to obtain it. Dr. Ives has established agreements in developing countries that have already been successful in applying biotechnology to produce better genetic materials for subtropical crops. She envisions expanded efforts to obtain information and exchange IPRs in order to better utilize biotechnology in developing countries.

Dr. Ives sees an IP clearinghouse serving as a bridge between technology holders in industrial countries, the universities and companies, and all those involved in research for developing country agriculture, including national agricultural research services (NARS), the international agricultural research centers of the CGIAR, universities, and other public sector researchers in developing countries, as well as aid donors such as the Rockefeller Foundation and USAID. The functions of such an IP clearinghouse would include patent database development and maintenance, with information on patents from the US, EU, and developing countries as well as information on the availability of technologies, such as current ownership, conditions for use, and steps for obtaining access. A second function would be to negotiate license agreements with technology providers and to arrange sub-licensing to qualified or specified technology users. A third function would be to distribute research materials or at least arrange for the shipment of necessary materials between parties to an agreement. A final and crucial function of an IP clearinghouse would be consultation and training services for developing world researchers, including review of external agreements, assistance in drafting technology transfer and intellectual property policies, education and training in intellectual property issues, and development of an 'expert/consultant' database. Questions that remain include the following: Who will pay for such a clearinghouse? Foundations, multilateral donors, industry, or the technology users? What will it cost? Who will run it?

Dr. **Richard Jefferson**, the founder and executive director of the Center for the Application of Molecular Biology in International Agriculture (CAMBIA), in Canberra, Australia, is a significant inventor in the area of plant biotechnology and has had extensive experience in defending and licensing his own as well as CAMBIA's intellectual property. Dr. Jefferson supports the idea of an intellectual property clearinghouse for international agricultural research, arguing that the unique nature of agriculture requires decentralized, democratic, and diversified technological solutions, all of which depend on access to the tools of technological innovation. He warns that detailed specifications matter: over-generalizations such as 'biotechnology', 'developing country', 'pubic sector', 'patent' need to be broken down and carefully clarified as the terms of a clearinghouse are spelled out.

Dr Jefferson suggested that such an institution would face severe limitations if not designed properly. He presented CAMBIA's technology access program as a model for such a clearinghouse, both for the innovation and dissemination of critical enabling technologies. Key features include:

1. clear and decisive (i.e., non-consensus) governance
2. catalyzing others' innovation
3. inventing around existing roadblocks
4. 'IP informatics', the provision of comprehensive IPR information
5. licensing priced on ability-to-pay, renegotiated any time ownership changes
6. universal access to licenses, with no reach-through agreements
7. an inventors' rewards system that combines private and public components.

He views a clearinghouse as an organization that has the right to manage technologies that are especially appropriate for developing countries but are also of value in other markets. The clearinghouse would negotiate with companies and private organizations, both obtaining rights and selling rights to technologies owned by others. It would make genomic databases available for researchers in developing countries, increase access to technologies, and provide income to inventors and developers of technologies that are useful in the developing world. Mechanisms that pool technologies and provide revenues and access to biotechnologies increase the utilization and benefits of these new technologies in developing countries.

For a clearinghouse to be viable and not rapidly become a white elephant, it would have to maintain accessibility to the latest key enabling technologies. Dr. Jefferson expects that the key enabling technologies in agricultural research will change in the near future with the emergence of site-directed mutagenesis, homologous recombination, apomixis, and other, yet unknown technologies. He envisions a general shift in methodology toward screening the genetic content of existing varieties to identify those with unique genetic makeup. Such an approach would allow development of new varieties through more traditional means, using biotechnology to obtain more information about the raw varietal genetic input for breeding processes. This would help overcome some of the current problems with or objections to biotechnology. Whatever the strategy,however, it is crucial for the newest biotechnologies to be made available to those in developing countries; otherwise, the other efforts of a clearinghouse would be essentially useless.

Dr. Jefferson suggested that, in organizations where individual researchers are allotted a percentage of royalty revenues, it is often the case that the intellectual property portfolio is managed to maximize each individual inventors' revenues separately rather than maximizing the overall utilization of group's technologies and research capabilities. Such a system, he argues, actually inhibits invention and application. Therefore, he suggested an alternative arrangement: that scientists in an organization contribute their patents under a partnership wherein all share equally in the royalty revenues. Thus, the organization would operate to maximize their collective benefits of developing and moving technologies out into applications.

Dr. **Robert Herdt,** vice president of programs at the Rockefeller Foundation, observed that so far today speakers have been advocating a clearinghouse for several rather different reasons, including

1. concern for food security, especially in developing countries, expecting a clearinghouse to make technologies more available in places like Sub-Saharan Africa or Southeast Asia;
2. desire for greater public acceptance of GMOs, anticipating a win-win deal to use private sector property for public sector goals, making the technology more broadly available;
3. concern that technology is lying dormant or that the rate of innovation is stalled, calling for the channels of technology application to be more widely opened for the sake of economic growth.

Dr. Herdt made it clear that his and the Foundation's concern is with the first of these—food security in the poorest countries—and raised an interesting question: If the latter two challenges are solved for the US, will that then help solve Africa's food security problem?

Food security certainly involves more than just intellectual property. Rockefeller's concerns for places like Africa include markets and transport, incentives, and agricultural inputs, as well as improved technologies. Technologies include crop production management techniques and better crop varieties. He expects the private sector to play a small role, providing fertilizers and hybrid seeds, but that the rest of the job, if anyone is to do it, must be done by the public sector.

Dr. Herdt described the international agricultural research system as it has existed since the 1970s: the CGIAR and the National Agricultural Research Centers have worked together with scientists from developed countries, local governments, and international donors to develop genetic materials that have prevented hunger in much of the world. The free exchange of genetic materials between research centers and countries as the 'common heritage of mankind' has been an essential element of the system. Changes in the international environment, however, have culminated in the ascendancy of molecular techniques and biotechnology, the privatization of technology under IPRs, and, in general, the global movement of knowledge, capital, and people, all changes to which the international agricultural research system has been slow to respond. With a sequence of international agreements (the Convention on Biodiversity and TRIPS), IP knowledge has become as important as biological knowledge if not more so. While the CGIAR system has many impressive assets, such as physical locations in the tropics, germplasm held in common trust, close links with national agricultural research systems, experienced staff, sound management, and diversified funding, it has been frozen by uncertainty and ignorance in the wake of these treaties. Transfers of knowledge about biotech and IP are not taking place, and the CGIAR is not meeting the developing countries' needs. In today's world it is essential that developing countries have their own understanding of IP issues, be able to negotiate internationally, understand the biosafety and environmental aspects of GMOs, conduct their own seed testing and perhaps plant breeding, and to pursue their own biotechnology research. Currently, however, the CGIAR is, with a 1975 structure, trying to deal with 21st century challenges.

In light of these problems, the Rockefeller Foundation is envisioning a facility to allow for the charitable use of IP for public research. Discussions of patent pooling experience in other technologies, such as the USPTO paper by Clark et al. on digital technologies, do not tell us whether it will work in agriculture. No one knows whether it will. An IP clearinghouse for public agricultural research could receive and manage IP donations on a strictly voluntary basis, while its proactive staff could go after packages of traits that are necessary together to produce desired crop improvements. It could then turn and offer the IP to the poorest countries royalty free. There are major questions, however: Who would capitalize it? How do you keep it going over time? How will it work? Would it be for-profit or not-for-profit? An existing model can be found in *Plant Biosciences Ltd.*, a small functioning, and profitable for-profit entity in the UK that pools and licenses IP. To what extent would the private sector participate? Given the precedents of vitamin A rice, they likely will, at least to the extent that they do not undercut their own ability to make revenues exceed costs.

In sum, according to Dr. Herdt, despite the gains of the last 30 years, there is still much to do. The current system is not rising to the challenge. Maybe we have to do something else to achieve our goals of food security in the poorest countries.

Session 4: Round Table Discussion

After the presentations, all the participants in the round table were invited to join in a round table discussion led by **David Zilberman.** The speakers who presented their ideas on an IP clearinghouse for agriculture in Session 3 served as the primary discussants.

The round table discussion revealed the variety of IP perspectives taken by the different participants and the variety of IP problems they face. There are clear differences among the different types of organizations in the incentives they face to managing biotechnology. A key objective of this round table was to identify the different needs that exist and (to at least begin) to define the basic underlying problems, to propose solutions to these problems, and to see where synergies might lie in the provision of solutions. Several types of interested parties were represented at the meeting, and participants provided the following explanations of their respective IP problems:

The interests of various types of agricultural research organizations in IP clearing

1. Universities

While universities are engines of technological change, they do not see much revenue from their technology. According to **Alan Bennett**, the director of the University of California Office of Technology Transfer, many universities have an inventory of unlicensed technologies. The biggest problem in university patent policy is the royalty-sharing arrangement. Since university inventors are entitled to significant shares of royalty revenues (often 33 percent or more), it is important in most cases, and even legally required, to get their approval for deals. In discussing alternative strategies to traditional licensing, technology transfer officers have to go inventor-by-inventor for approval. For example, to license genes to developing countries on a royalty-free basis, technology transfer officers have to go to the individual faculty inventor and explicitly agree to the deal because the office may be giving away the inventor's potential income and can be sued for mismanaging the inventor's intellectual property.

One of the participants, **Ana Sittenfeld**, a professor of plant biology at the University of Costa Rica, argued that in many cases it is easier to deal with major corporations rather than with universities in licensing technologies. Major companies at least come to a definite decision in a short period of time, and occasionally they may provide scientists in developing countries free access to their most important innovations and know-how. Universities respond in a slower manner and also may not always provide access to their technology. Others, including **Alan Bennett**, responded that the university is not wanting to 'say no' but rather is wanting to arrive at terms that will work for all parties, including the faculty inventors, in order not to lose an opportunity for revenue generation. This of course slows the negotiation process and thus prolongs negotiations. Universities are not as deal oriented as companies, but that is changing.

Universities also are not in the business of developing complete technology systems or assembling complementary sets of IP in house. This means, on the one hand, that many of their individual unlicensed patents, which are potentially useful, are not licensed because they are not made available together in a package with the other necessary complementary technologies. Another result of not actively managing technology packages within the university is the danger of university researchers running into hold-ups in which they are refused permission to use a technology that is necessary to continue or to commercialize their research project.

According to **David Zilberman** another major role of universities, as engines of technological change, is the encouragement of entrepreneurship through technology transfer offices that provide services needed to help faculty start companies based on their technologies when established companies are not interested in licensing and commercializing. However, entrepreneurship, according to **Catherine Ives**, requires a unique environment and, in most states, university technology transfer offices fail to drive entrepreneurship in their universities.

2. Public Sector in Developed Countries (such as the USDA-ARS)

According to **June Blalock** of the USDA-ARS office of technology transfer, the USDA has little trouble getting access to patented technologies for research purposes--the real complication is commercialization, when the public sector is putting something directly into commerce. They do occasionally suffer some egregious reach-through license agreements that tie up commercialization, but these usually come from smaller parties less experienced in dealing with intellectual property. She claimed that in many cases IP is not necessarily the biggest barrier to commercialization; instead, marketing, regulatory, and biosafety issues are more difficult.

3. *Minor Crop, Horticultural Crop Interests*

According to **Alan Bennett**, minor and horticultural crops in California and in the US in general have had to rely heavily on the public sector to meet their technological and germplasm needs, but even so there is not a lot of activity in horticultural crop development.

With growers of specialty crops, some of the main problems in taking advantage of biotechnology appear related to the reluctance among companies to further adopt and market new genetically modified varieties because of concerns about consumer acceptance and the small sizes of the individual markets.

4. *Public Sector Agricultural Researchers in Developing Countries (including CGIAR, NARS, universities, and other agricultural research institutions)*

While several of the presenters in the earlier sessions spoke as specialists on international agricultural research, according to **Karim Maredia**, of Michigan State University, it is important to seek more direct input from the national agricultural research services (NARS) of the developing countries about their IP needs. Accordingly, the greatest IP problems in developing countries are ignorance of IP policy, which is clearly compounded by the complexities and current transitions in such policies, and the associated lack of IP management capacities.

5. *Agricultural Companies with Limited Biotechnology and IP Expertise, in all Countries (developed and developing)*

Small agbiotech, seed, and agricultural input companies, cooperatives, farm organizations, and the processors and producers of agricultural output tend to have small IP portfolios, if any. Even in the cases where companies do have some IP, they may be shut out of the game by the high transaction costs of accessing the complementary intellectual assets necessary for further technological development. In particular, they often need access to enabling technologies or research tools. They also tend to be disproportionately weaker in complementary assets such as patent information or innovation management systems.

In many cases such agribusiness companies or coops are not utilizing the full potential of biotechnology for their operations. Even when these organizations identify technologies especially relevant and useful to their line of business, they often do not fully understand the importance of IP and the value of accessing technology packages that assemble multiple permissions.

6. *Large Multinational Companies Specialized in Ag-biotechnology*

Carl Pray, professor of agricultural economics at Rutgers University, pointed out that it is really quite expensive for companies to give technologies away, particularly to go through the necessary regulatory processes and to control for liability. He noted a study or review done at Monsanto recently to calculate the cost to the company of donating technologies that found the sum quite significant.

Mr. **Bruce Morrisey**, corporate counsel and IP group leader for agbiotech licensing at DuPont, explained that freedom to operate is a real concern for companies just as it is for universities and others. They invest time and resources in order to decide where they will need the freedom to operate and then take the necessary measures to get the rights they will need. Despite early problems in establishing confidence and trust, companies are interested in developing countries and in continuing to grow relationships there.

He believes that companies would be interested in participating if certain reasonable conditions can be met in the terms for licensing technologies through a clearinghouse. Companies would be willing to work not only on a technology donor basis, but would likely want much more involvement, and may be interested in taking on some of the risk.

According to Dr. **Michael Murray**, global leader of biotechnology licensing and alliances at Dow AgroSciences, making transgenics is a tough business to be in right now. The greatest limitation to firms' abilities to advance better technologies for growers, consumers, and regulators is actually the inefficiency of plant genetic transformation systems, which is an example of why companies are looking for new tools all the time. They would be very happy to see the public sector developing more tools and making them available. He also pointed out that companies do not like to work in the midst of horrendous IP barriers when they are trying to develop products.

7. International and Non-Profit aid Institutions

It was clear from the earlier presentation of **Robert Herdt** that work sponsored by the Rockefeller Foundation for food security in developing countries is impacted by IP complications. Also, according to **Carl Pray**, the international development banks are struggling to figure out what to do about biotechnology: in particular the Latin American Development Bank and the Asian Development bank are looking for innovative solutions to help small players get access to technology.

Basic roles of a clearinghouse:

The participants were able to articulate at a high level of analysis their common interests in creating services that would:

- provide them with access and permission to use knowledge
- increase their capability to innovate
- increase their flexibility in using IP protected research tools
- reduce their IP transaction costs
- simplify the game of IP in technology commercialization and product development
- facilitate complex or multidirectional technology transfers.

'Technology transfer' was characterized by **June Blalock** from the USDA-ARS as the formation of a series of informal joint ventures where IP transfer is simply the basis for a partnership between someone with an underdeveloped or unapplied technology and someone else with the necessary complementary assets to further develop that technology.

Under such a perspective, a 'clearinghouse' would be a better, more efficient way to discover such opportunities and form such informal joint ventures—as well as manage more of them more effectively. In particular, a clearinghouse could serve as a partner for assembling all the complementary IP assets needed for a project, so that a technology transfer manager would not have to focus on all the small details of multiple transactions, thus providing the shortest route to their goals and allowing them to focus on the bigger questions of the project.

From the perspective that agriculture is an enormously decentralized activity, **Richard Jefferson,** director of CAMBIA, emphasized the decentralization of agricultural innovation, focusing on the diversity of agroecosystems and societies, as crucial. He envisions an IP clearinghouse as a way to encourage the decentralization of agricultural R&D by providing knowledge and permissions on terms that encourage potential innovators within those different agroecosystems and societies. They would embrace risk and invent or develop whatever they might conceive, if they were not constrained by IP holdups or encumbered by excessive royalties. They would be able to carry their own new ideas forward as decentralized entrepreneurs in agricultural innovation. In his view, such a clearinghouse functions to nurture in-country innovation instead of importing relatively mature technologies.

Anna Sittenfeld of the University of Costa Rica—echoing a question posed by **Robert Herdt** in his presentation—suggested that clearing up the IP log jam in the developed countries would in itself go a long way in helping developing countries negotiate access to new technologies. From this perspective, an IP clearinghouse that served primarily to put in order the house of developed country agricultural innovators would have wider effects in the developing world.

A general deployment of ag-biotechnologies for the developing world?

Upon initially considering the concept of an IP clearinghouse, several participants wondered whether a 'general deployment agreement' might be worked out with companies and universities for the application of agricultural technologies in all developing countries.

Ana Sittenfeld replied that, because 'developing countries' are all very different, a blank check for technologies is probably not going to be very useful. **Robert Herdt** commented that it would be difficult to get general permissions because of market segmentation: firms are not interested (nor is Rockefeller Foundation) in giving markets away, a situation described by **Bruce Morrisey** from DuPont as "the embarrassment of facing your own technology compete with you in a new market." Mr. Morrisey stipulated that, for companies to be interested, clearinghouse agreements would have to include for each technology clear restrictions on the scope of rights being shared: For what crops or products can the technology be used? In what territory can these be marketed, including restrictions on agricultural exports grown with such technologies to prevent unexpected fallout in other territories? Any clearinghouse agreement must look at specific technologies and specific products.

Richard Jefferson and others raised questions over the importance of being precise when establishing criteria to implement any general policy for complex issues. He argued that agricultural areas encompassed by developing countries are very heterogeneous, and that there are significant variations within individual countries. For example, the coffee and citrus sectors of Brazil are world class in terms of their research capacity and ability to adopt and introduce technologies. Some regions in India are very well connected to markets, and they have outstanding technical capacity to generate and adopt technologies. Yet, in these same countries there are also regions that are more traditional and not well integrated into world markets. They rely on traditional varieties, and their capacity to generate and absorb new technologies is quite limited. The significant variation in productive capacity and ecological conditions in Africa also presents a challenge for technology development. Developing and introducing biotechnologies for such regions presents special challenges and will likely be left to the public sector. Thus, a key requirement of any IPR reform is to allow flexibility that recognizes heterogeneity and diversity, not the inflexibility of stylized technologies generally available everywhere.

Similarly, the notion of 'biotechnology' is overly broad. It includes wide varieties of technological elements that are not all appropriate or adaptable to the capabilities and conditions of all locations. An important feature of any adaptation to the system of IPRs and technology transfer, is the capacity to discriminate, to pick and choose, and to enable appropriate technologies in terms of profitability, adaptability, and environmental impact to be developed and introduced in various locations as new technologies evolve.

IP clearing of 'process' vs. 'product' technologies

Would there be a difference in providing access to research-enabling technologies (research tools or process technologies) versus trait or product technologies (such as specific genes and enhancements, or product technologies)?

Michael Murray from Dow replied that licensing out enabling technologies is always easier because there are fewer 'product stewardship' (i.e., regulatory and liability) issues: the technology you provide does not end up actually in someone else's product, and you do not have to trust their competence in managing the biosafety and regulatory issues associated with your technology. As an example, **Bruce Morrisey** described the licensing arrangement created by Cornell, which is still offered by DuPont, for the gene gun: anyone interested in using the gene gun automatically gets a blanket research and commercialization license from DuPont without any reach-through restrictions when they lease a gene gun. **June Blalock** concurred that a non-exclusive arrangement would work best in providing research-enabling tools. Unique product related technologies on the other hand often need the incentive created by granting an exclusive monopoly (i.e., by patenting and exclusively licensing) simply in order for the licensing company to be able to raise the capital needed to develop the technology.

Richard Jefferson emphasized that a hypothetical clearinghouse should focus on providing specific research-enabling capabilities (akin to what **Alan Bennett** identified as 'core capabilities' in his proposal for the horticultural crop transformation consortium) by assembling 'suites of permissions' or micro-pools of specifically complementary patents, with each such 'capability suite' available separately to users at their own discretion and at a royalty rate based on their own ability to pay. By managing individual 'capability suites', a clearinghouse would not only meet the needs of users more effectively but would also induce individual inventors more strongly to contribute their patents, since the clearinghouse would offer the incentive to receive a share of any revenues generated by that specific pool. More valuable technology contributions might be rewarded with additional shares. He agreed with the others that trait or product technologies that add immediate net value and require biosafety stewardship should be avoided. Appropriate new core technological capabilities, such as functional genomics tools, could be added as new packages or 'capability suites' at any time.

Incentives for IP owners to make their technologies available through an IP clearinghouse

When products primarily serve the poor and do not have much of an effect on international markets, private companies as well as universities are likely to provide access to their technologies on quite favorable conditions. The behavioral patterns of private firms in the past indicate their willingness to provide access to technologies in developing countries and even in some sectors of developed countries under favorable conditions, as long as they are confident that the technology will be used appropriately. This condition is due to their concerns about liability and negative publicity, as well as their interest in ensuring that the use of the technologies does not compete with their paying customers.

What incentive structure should be offered to small inventors to contribute to a pool of technologies? It may be important to consider alternative mechanisms for revenue sharing of innovations since, given the nature of patents, inventors push for IP licensing decisions that maximize their own royalties rather than the good of society.

Richard Jefferson expanded on the idea he introduced in his presentation, that of equally sharing royalties within a reasonably small sized group of inventors. This model is employed at CAMBIA and may be appropriate for revenue sharing among the contributors to a clearinghouse: 20 percent, for example, of the royalty revenues from a pool of patents is divided equally among all the inventors of the constituent patents. Given this arrangement, the inventors, on average, benefit from the licensing of other's inventions, for the large majority of patents left alone would not be licensed at all and their inventor would earn zero royalties. The inventors in the pool may even be encouraged to collaborate with one another in order to collectively advance their own individual incomes. To induce some inventors to stay in a pool or to contribute an additional essential piece of technology to complete a 'capability suite', the clearinghouse may need to offer additional 'incentive' shares or offer other compensation such as research grants to support the inventor's laboratory.

Alan Bennett indicated that there is not much latitude for trying to develop new royalty sharing mechanisms such as this share-type system within the university. However, participation in an outside licensing mechanism or pool would be up to an individual inventor. He affirmed that, in the university, there is generally goodwill and interest among the faculty inventors for their technologies to be used for the public good.

In any of these scenarios, the IP owner's decision to make her technologies available is purely voluntary. While none of these mechanisms has the power to prevent IP owners from holding up a technology's commercialization for extortionate royalties or for indirect strategic or liability reasons, most of the IP stakeholders who spoke up in the discussion indicated that, given less costly and responsibly managed mechanisms, they would be willing to license their technologies to those who could make good use of them.

IP education and capacity development

There is much honest uncertainty and ignorance, especially in developing countries, about both what biotechnologies can and cannot do and about what intellectual property can and cannot do. One apparently widespread misunderstanding is an *over*estimation of the strength and applicability in developing countries of IPRs.Much is made of patents in force in developed countries, particularly the U.S., when in fact the technologies they cover are not patented in many developing countries.

Karim Maredia, of Michigan State University, said that a clearinghouse must continually address this capacity building issue and include education and training as components. In order to be successful it is important to develop basic IP awareness as well as IP management and negotiating skills among potential users. He speculated that even if an IP trading or technology transfer mechanism were made available immediately to developing countries few would be able to use it.

It is similarly important to engage and educate cooperatives, farm organizations, and the processors and producers of agricultural output in the U.S. and other developed countries about the potential benefits and risks of biotechnology, so that they can objectively assess specific innovations that may be of value to them and their customers, clients, or members. They also need to be educated about the importance of IP considerations, about how to access technologies through licensing arrangements, and about how to manage technology packages that are core to their line of work.

IP clearing and patent law reform

In response to questions, such as those raised earlier by **John Barton** about the need for the reform or tightening up of policies on what is patentable, participants arrived at a loose consensus that it is probably a good idea to "leave bad enough alone." **Bruce Morrisey**, the patent counsel from DuPont, reminded the group that the pendulum of patentability in biology has swung to both extremes and that the creation of loopholes, exemptions, and special restrictions always end up having unintended consequences. **Larry Fox**, the director of the UC Davis Technology Licensing Office, concurred, pointing out that in the '80s it was very difficult to get a biotechnology patent. One had to pay high users fees, while today too many patents are being issued with the same claims, leaving it to the courts to decide validity, which is making intellectual property protection much more expensive, with enormous legal fees added on top of the users fees. He contends that, while there are serious problems of execution both in the administration and in the management of the Patent and Trademark Office (PTO), the patent system is not fundamentally broken.

Carol Nottenberg, the director of intellectual property for CAMBIA, pointed out that patent law reform is not at all straightforward. While Congress may enact the basic laws and the PTO has leeway to make some of its own internal rules and regulations, it is the courts that interpret and apply patent law, and that is a much more difficult institution to change. It was the courts, for example, that took away breadth of patents and that tightened standards of infringement. **David Kryder**, from ISAAA, warned that patent reform would likely be done "by the same people that brought you tax reform" and on those grounds suggested that working within a known, albeit imperfect system may be preferable to risking the alternatives.

Ana Sittenfeld, of the University of Costa Rica, reminded the round table that major patent legal changes are currently underway in many developing countries as they come into compliance with TRIPS. Costa Rica's new patent law came into effect on January 1, 2001, and immediately the patent office was overloaded with biotechnology patents. To help handle the enormous job university faculty are making the reviews. Most of the applications are from foreign countries motivated in part because it is very inexpensive to patent in Costa Rica. Before this year patents were not registered and technologies used in production in Costa Rica did not face any infringement problems. Now with the rules of the game changing and technologies beginning to be registered, the situation in Costa Rica and in other developing countries will become more difficult, giving urgency to finding a clearinghouse mechanism to clear conflicting property claims.

Developing an entrepreneurial spirit in the public sector and in developing countries

It was emphasized by some of the participants that developing IPR regimes and biotechnologies is not done in a vacuum. Mechanisms to introduce technological capabilities and capacities to absorb knowledge depend upon and are affected by other policies and the development of other, related, capabilities. Some important features of the American system that could be emulated are its entrepreneurial spirit, the ability of individuals to modify their career choices and activities, and to approach financial institutions for funding in order to take advantage of opportunities.

Companies started by university professors and funded by venture capitalists have developed many of the breakthrough agricultural and medical biotechnologies. Some of these organizations later grew to become major companies or were taken over by larger companies in the industry. There is sometimes a wide gap between the basic ideas covered by patents and the actual commercial applications of those ideas; the involvement of researchers in the development of such commercial applications is often crucial for the success of the innovation system. Thus, providing funding opportunities and establishing the institutions to enhance entrepreneurship and risk taking in developing countries are all very important. Developing general entrepreneurial skills to take advantage of new tools is more important with the availability of new technologies.

Biosafety regulations and an IP clearinghouse

Participants emphasized that for many there is a larger concern than IPRs, among the emerging 'rules of the game' of agricultural biotechnology, and that is biosafety. GMO registration requirements—designed to test and approve safe biotechnologies for market—may indeed prove to be the greater barrier to involvement by a more diverse set of players in developing new biotechnologies and other agricultural technologies. The large costs involved in regulatory testing and approval processes are difficult for smaller businesses and publicly funded research organizations to cover particularly on technologies in the public sector that are to be 'given away'. In essence, the argument is that stronger regulations favor more commercially lucrative developments and the companies with the size and resources to pursue them. Environmental and health safety are obviously the most important aspects to consider when establishing approval and registration procedures. However, the impacts that such regulations have on innovation and industry structure should at the least be acknowledged and addressed.

An IP clearinghouse could serve to clarify registration requirements, particularly across different countries, to innovators as it assists them in making IPR arrangements. It could also exercise economies of scale by enabling multiple-country registration, to reduce the cost, particularly for small players, of introducing environmentally safe and healthy products.

Potential existing models and case studies of IP clearinghouse mechanisms

In the course of the discussion a number of suggestions were made by participants to look at specific existing organizations or arrangements that might serve as models or suggestions for important aspects of IP clearing functionality:

- ISAAA (Cornell): models of international technology transfer deals
- ABSP (Michigan State): models of international IP capacity building and education, technology transfer deals
- Plant royalty bureaus: funding of operations out of facilitated transactions
- Plant Biosciences Inc. (UK): patent pooling and licensing services
- International AIDS Vaccine Initiative: design of the intellectual property aspect
- Stanford University: example of successful university office of technology transfer
- CAMBIA: intellectual property "informatics" online resource
- CAMBIA: ability-to-pay licensing royalty fee policy and equal-share inventor royalty-sharing policy
- The Patent and Licensing Exchange: symmetry of information provision, price discovery process, transaction management, and risk management functions
- Aurigin Systems: IP data access, Aureka IP information management platform, and analytical systems.

Next Steps Recommended from the Floor of the Round Table Discussion

➢ *Define the individual IP-related problem(s) clearly and succinctly and set parameters for solving the individual problem(s). Allow overlap in parameters for individual solutions to suggest mutual solutions.*

The participants at this round table were posed with a classic problem solving exercise. There are clearly multiple overlapping problems, and it is difficult to clearly define and demarcate them separately. While it is beneficial to include in the discussion as many potentially affected parties as possible, any concrete institution building must be done on clearly defined conceptual foundations.

➢ *Seek input from the potential clients of an IP clearinghouse in order to assess what they would like to see and how they would be able to benefit from an IP clearinghouse.*

A clearinghouse for agricultural IP will be to a large extent a service offered to agricultural researchers. It is essential therefore to begin with interviews, focus groups, and case studies to identify actual needs for IP capacity building, IP information services, patent bundling and pooling, patent exchange, or other yet unspecified mechanisms. For the international agricultural research community, special care should be taken to assess the needs of the national agricultural research systems (NARS) of developing countries.

- *Focus on access to information, what information would be most useful to whom, what interpretation and analysis needs to be offered with it, and particularly on opportunities for partnering publicly available information resources with private information tool providers.*

While the whole world's repository of IP information and published biological knowledge are in principle publicly available, in practice it is costly to access and search through the terabytes of data in the virtual information universe. Furthermore, it is important to know and serve the capabilities and needs of the various clientele. The services should assist them in finding, understanding, and organizing the relevant pieces of information so that they can ask the right questions about complex technological systems that they may be interested in developing or acquiring, and so that they can be given useful answers.

- *Wherever possible, develop partnership arrangements within individual sectors. For instance, public institutions and universities could pool or combine IP portfolios based on the identification of mutually complementary technology components.*

This recommendation for public organizations is based on the ideas of **Alan Bennett** and the interests he described among universities in a consortium for sharing horticultural crop transformation technologies. Advanced tools to recognize patterns of technological similarity and complementarity could be applied to identify potentially fruitful partnerships in the public sector. Companies could seek among themselves a more transparent cross-licensing regime. CGIAR centers could seek to coordinate IP policies and share IPRs among themselves and with other international public sector partners.

- *Explore potential strategies for meeting the IP needs of different sectors with common mechanisms; in particular, the needs of specialty crops and developing countries should be explored together.*

It was recognized that growers of specialty crops in developed countries and small-scale or marginal farmers in developing countries are both likely to be under-served by the technologies developed by major companies. Thus, both need public sector involvement to develop technologies and to gain access to IPRs. Since they have much in common, a common solution may serve both. For example, universities and other public sector technology developers in the developed countries may share knowledge and give each other mutual IPR access to develop tools that improve specialty crops. At the same time, for example, there may be significant value in pooling their IPR and other knowledge assets for (at least some groups of) developing countries, allowing their public researchers to gain regional access to the knowledge and rights of universities from the developed world.

- *However, the variety of needs may require a variety of different solutions. Expect to take separate steps for different parties' interests.*

Alternatively, however, there may need to be separate solutions for each of these sectors (but with some elements of collaboration.) As observed by **Ana Sittenfeld**, in the U.S. small private firms and universities have similar problems in accessing and managing IP, but they are able to pay at least modest royalties. Accordingly, perhaps the solutions for them can be contracted out to, or created from the ground up, by a private firm. Similarly, the larger players in the developing world, such as Savia in Mexico or Mahyco in India who have IP capacities and certainly can pay royalties, would also be able to use such a service. However, many other smaller entrepreneurs and research centers, particularly in the developing world, would not be able to work under such a solution and would need more help. A publicly funded agency would thus likely be needed to provide suitable IP solutions for them.

- *Pre-test specific potential clearinghouse mechanisms with empirical studies or simulations.*

Nir Kossovsky, of the Patent and Licensing Exchange Inc., offered the use of his company's software and systems for a simulation study of the exchange of agricultural biotechnology patents, to see what IP would potentially be offered in an agricultural IP clearinghouse. If reasonable data can be provided to describe what technology buyers would be requesting, a model simulation could analyze the extent to which the potential technology users' needs could be met using the patent exchange system.

- *Identify what specific technologies, particularly among research enabling tools, are necessary and appropriate for an IP clearinghouse to deal in. Determine what conditions or stipulations the owners of those technologies will need to be respected.*

Depending upon the immediate goal of a clearinghouse, specific technologies in which freedom to operate is needed by clients of the clearinghouse will have to be identified, and the combinations of patents under which they are practicable will need to be determined. The owners of the rights represented in those patents must be approached and terms negotiated.

- *Focus on organizational questions of how such IP clearinghouse organizations can be structured and funded.*

Many questions remain as to exactly what form such a clearinghouse institution, or network of institutions, could take. Should a single organization be founded with a commercial arm and a non-profit arm? Should separate services be established by concerned parties in their own sectors, which could then represent them and negotiate on their behalf with others? Could a central hub to such a network of sector-specific clearinghouses provide generalized services, such as IP information listings and flows of royalty payments (a hub-and-spoke organization)? Would private investors be interested in backing any part of such a venture? Would the public sector view such a venture as legitimate if backed by private investors? Which non-profit organizations would be willing and appropriate supporters?

- *Get beyond the generalities and designate a smaller subset of people to start work on specifics.*

Several participants volunteered their professional involvement in forming a collaborative initiative to further discuss and develop the proposals raised in this round table.

Contact Address for Further Information on the IP Clearinghouse Mechanisms

Those interested in any aspect of IP clearinghouse mechanisms discussed in this summary and those interested in being notified of any future discussions or meetings on this topic are invited to contact the round table organizers at:

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