AN INDUSTRY-ACADEMIA-INTERNATIONAL DEVELOPMENT ROUNDTABLE WORKSHOP:

INTELLECTUAL PROPERTY CLEARINGHOUSE MECHANISMS FOR AGRICULTURE

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UNIVERSITY OF CALIFORNIA

A SUMMARY OF WORKSHOP PROCEEDINGS

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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 motivated by the perceived underdevelopment and underutilization of new agricultural technologies and the continuing concern of researchers at universities and public sector research institutions—in both the United States and developing countries—with their lack of access and their limited capacity to commercialize new technologies because of intellectual property (IP) considerations. Over 90 participants were in attendance from a variety of universities, companies, and US government agencies. [i]

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Executive Summary: Conclusions and recommendations from the workshop

The following are general conclusions drawn from the proceedings of the workshop:

1. Development and application of appropriate biotechnologies have 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 restricted access to IP, consumers' lack of acceptance, and uncertain government regulation.

3. If mechanisms were implemented to reduce the costs of transacting 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 transferability of technologies 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 transactions costs) leads to neglect of large segments of agriculture, most notably minor crops and large parts of developing world agriculture. Neither private incentives nor public sector funded mandates suffice to meet the R&D needs in these sectors.

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, most notably as a result of broadly defined property rights in individual patents and single products involving technologies claimed by multiple IPR holders.

7. IPR interactions within the international agricultural research community are plagued with transaction costs resulting primarily from confusion over the proliferation of nascent IP policies in many countries, the lack of coordination of those policies, and the lack of education and experience on the part of 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.

The following are recommendations for cooperation to be undertaken to meet needs identified in the workshop:

1. Research and development for minor crops and agricultural research and development for developing countries share similar needs for a 'multilateral office of technology transfer' to perform such functions as negotiating for them as a IP 'group buyer', obtaining and managing access to rights, and managing the internal exchange or pooling of their own IP.

2. In two kinds of cases there is a potential role for 'IP aggregators':
    a. When many small parties are involved, the aggregation of their IP interests, providing quick and easy access to technology licensing markets, would reduce their 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 generally accessible on reasonable terms, reducing the transaction costs of 'shopping around' for the pieces of that technology system.

3. All R&D sectors of the agricultural economy need better information and better access to technologies. All could be well served by mechanisms that do the following to reduce IPR-induced transaction costs:
    a. Identify who has which rights to which technologies
    b. Conduct objective valuations of IPRs and design compensation schemes
    c. Standardize processes to obtain licenses
    d. Manage flows of royalty payments
    e. Enforce contracts

4. Education in practical policy and legal issues of IP 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 do the following:
    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: Opening remarks

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 conference was organized because the current situation in the agricultural biotechnology industry seems to ripe for a discussion of mechanisms to reduce transaction costs and remove excessive barriers to using proprietary technologies. The general goal of the workshop is to discover and to share in a public forum the possibilities for cooperation, exchange of knowledge, and transfer of technologies that have 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 depends not so much on the scientific results of the inventors as they do 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 an increase in the cost of research and a decrease in the rate of discoveries that depend on the utilization of new technologies. This is basically a result 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, 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 with obtaining license to use a 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 that every country have an IPR system for plant varieties, many developing countries may be better off introducing a plant breeders' rights system rather than 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 can lead individuals and organizations to be too conservative in their use of proprietary technologies. This can lead to significant underutilization of agricultural biotechnology and impose unnecessary restrictions on agricultural research, calling for both streamlining of international IPR agreements and more rigorous standards for granting patents.

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 terms of the alleviation of hunger and pointed out how new technology was a crucial part of the equation for developing countries. Then looking at estimated increases in population in developing countries in the future and the fact that yields due to Green Revolution technologies have plateaued, he argued essentially that, if the equation of success is to continue, new technological advances for developing countries will need to come from molecular biological and genetic technologies. While citing much potential for application of 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, began by emphasizing 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. One of the strengths of the public agricultural research system was free access to most inputs including germplasm and free transfer of information. The argument that, in the US only the private sector does effective research, is not only historically false but is 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 while 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 (IP) protection and encouraging the international proliferation of strong biotech IPR.

The first round of agbiotech was approached enthusiastically, leading to development of research tools, input substituting traits, and output traits. The first round of any regime 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"[5]. Third and fourth rounds will only get worse with exponential growth in patenting and the fact that 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 said to be protected by 70 to 100 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,

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[5] Michael A. Heller and Rebecca S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research," *Science*, 1998 May 1; 280: 698-701

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 that are typically allotted a third of their patent's licensing revenues to be willing to contribute 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 portfolios of IP. Consolidation of 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 to allow 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 workshop 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 semiconductor industry. In spite of the complexity and interdependency among firms in the semiconductor industry, he pointed out, 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 result in the pushing of IP transaction costs into the price of the final products, making them overly costly, under produced, and underutilized, thus leading to a sub-optimal resource allocation in the economy.

In the case of the semiconductor 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 member 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 have the lion's share of either the value or cost of production. When technologies are shared and the 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, and 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. Conversely, large companies may use their position as sole buyers to force small companies 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, new technologies are being actively introduced by independent startups, and the owners of 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 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 of and, thus, the foundation for 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 regarding expected benefits from using the patent and a measure of the uncertainty regarding its success, both of which are difficult but not impossible to provide in some form. Say for example that 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 is aimed to allow calculations under various assumptions. In 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 even though the search terms they specified do not create exact hits, a so called '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 information availability about the market and information symmetry between buyers and sellers, to decrease search costs, to provide some kind of objective measure of patent value to 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 arise in response to these three speakers. We expect that several of the organizations with significant endowments of intellectual property (i.e. that already have an 'in-house' patent pool or pool of 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 be, 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 various 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 computing tools are already available to deal with the complexity of biological and IP information. The information and software technologies presented in this workshop provide examples of the vast array of new developments for the identification, analysis and comparison of technological and legal content and for the economic value estimations of 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 dealing in exchange of IPR and for those who support or facilitate IPR exchanges. Some of the historical challenges that have been associated with excessive costs and demands of trading IPRs can be significantly reduced. Certainly 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 is to address and the needs of the various users, and there are a number of potential tools and mechanisms that can be used. In some cases, a clearinghouse can play the simple role of matchmaker, where parties negotiate a deal and perhaps execute the transaction. Such a clearinghouse perhaps helps to establish a price for the technologies, at least as a starting point for negotiation.

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

Session 3: Visions of an IP clearinghouse for agriculture

The third session of the workshop 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, but first he had to gain confidence in and establish trust in his guide. These qualities of confidence and trust, he argued, are the key requirements for any arrangement of exchanging technologies and cooperation between individual technology stakeholders, both in the developed and developing countries. He described 'confidence' as growing from the capability to perform and 'trust' as being 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 bad experiences already encountered.

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 they trust that they can enter into a legal and moral agreement and make the project successful.

What can an IP clearinghouse do to develop confidence and trust? Foremost it can develop a clear understanding of what the parties need and want. Potential recipients and donors need to lay all their needs and interests out on the table so these 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; that which the organization claims will be the basis on which it is established and is that which it will thereafter be expected to do. 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 it will be able to accomplish.

There have been several attempts at collaboration and sharing of 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 conservation of crop genetic resources, crop breeding activities that provide finished cultivars to the local agricultural industry, and 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 are not involved in the development of crops with biotechnologies.

The community of land grant universities and agricultural experiment station crop researchers has been discussing for some time possible pathways toward developing 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 development of traits with low commercial but high social value. This would also decrease barriers to commercial development of transgenic horticultural crops. 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 those 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 fit together with them to create a value that goes beyond the single technology. The university is motivated to find strategies to make these available to the public, either commercially or otherwise.

The first major component of the proposal included four primary objectives. First was the development of a database annotated for researchers to know what patented technologies were available from the pool and on what terms. Second was management of a repository for enabling technology materials to distribute them to researchers. Third was the negotiation and administration of material transfer agreements (MTAs) for resources not in the public domain. Fourth was 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 the creation of a national network of 'transformation service and training centers' at the universities, which 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. The general idea is this: there are extensive public resources available, but there has not been an organized effort to pull these together to 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 product for the poor because of poor farmers' 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. 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 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 distribution of research materials or at least the arrangement for 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, whether 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 envisions 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 will face severe limitations if not designed properly. He presented CAMBIA’s technology access program as a model for such a clearinghouse, in terms of both 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 will make genomic databases available for researchers working in developing countries, will increase access to technologies, and will 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 has to maintain access 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. It will be better to screen the genetic content of various seeds to identify those with a unique genetic makeup. This policy will allow better screening of genetic materials and may help to develop new varieties through traditional means by using biotechnology to obtain more information about the raw input for such processes. This will help overcome problems or objections to biotechnology. However, it is crucial that the newest biotechnologies will be available to members of developing countries; otherwise, the other efforts of a clearinghouse will be rendered useless.

Dr. Jefferson suggested that in organizations where individual researchers are allotted a significant percentage of royalty revenues, it is often the case that the intellectual property portfolio is managed to maximize individual inventors’ revenues rather than the overall utilization of technologies, both in terms of 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 operates under well-focused leadership and maximizes the collective incentives and benefits of developing and using technologies.

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 may 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 LDCs' needs. In today's world it is essential that LDCs 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 they may even wish to pursue their own biotechnology research. The CGIAR with a 1975 structure is trying to deal with 21st century challenges.

In light of these problems, Rockefeller Foundation is envisioning a facility to allow for 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 royalty free to the poorest countries. 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: Roundtable discussion

After the presentations, all the participants in the workshop were invited to join in a roundtable 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.

A variety of interested parties, each with different needs:

The roundtable discussion revealed the variety of IP perspectives taken by the different participants and the variety of IP problems they face. There are also clear differences among the different types of organizations in the incentives they face to managing biotechnology. A key objective of this workshop 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 there might be synergies 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:

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, in fact 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 (sometimes 33 percent or even more), it is important, and even legally binding, in most cases to get their approval for deals. To discuss alternative strategies to traditional licensing, technology transfer officers have to go inventor-by-inventor. For example, to license genes to developing countries on a royalty-free basis, they 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 with the provision of services by offices of technology transfer needed to help faculty to 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 offices of technology transfer fail in trying 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 patented technologies for research purposes, but the real complication is in 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, but that it is more difficult to deal with marketing, regulatory, and biosafety issues.

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 on the public sector to meet their technological and germplasm needs, but there is not a lot of activity in horticultural crop development.

With growers of specialty crops, some of the main problems with taking advantage of biotechnology appear to relate to the reluctance among companies to further adopt and market new genetically modified varieties based on 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 on their IP needs. Accordingly, the greatest problems in developing countries in relation to IP 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 at all. 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 complementary assets necessary for further technological development or for good management of their IP portfolio. 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 see 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 them by assembling multiple permissions.

6. *Large multinational companies specialized in agbiotechnology*

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 to calculate the cost to the company of donating technologies finding 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 measures to get the rights they will need. Despite problems early on in developing confidence and trust, companies are interested in developing countries and in continuing to develop relationships there.

He believes that, if certain reasonable conditions can be met in the terms for licensing technologies through a clearinghouse, companies would be interested in participating, not only on a technology donor basis, but would actually 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.

He felt that another fundamental problem is that researchers in molecular biology, who get excited by genes and gene functions, have never been on or near a farm. Companies and other research organizations need to get those who create the technologies connected up with agricultural realities.

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, in considering how to help small players get access to technology, are looking for innovative solutions.

Basic roles of a clearinghouse:

It was possible for the participants in the discussion to voice at a high level of analysis their common interests in the creation of services that would:

- provide them with access to and permissions 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 transfer of IP is simply the basis for a partnering between someone with an underdeveloped or unapplied technology and someone else with the necessary complementary assets for that 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, and to manage more of them more effectively. In particular, a clearinghouse could serve as a partner who can assemble all the complementary IP assets needed for a project, so that you as a technology transfer manager do not have to focus on all the little transactions that you otherwise would have to, thus providing the shortest rout to accomplish your goals and leaving you to focus on the bigger questions of managing the project.

From the perspective that agriculture is an enormously decentralized activity, **Richard Jefferson,** director of CAMBIA, sees 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 to embrace risk and to invent and develop whatever they might conceive, if they were not constrained by IP holdups or encumbered by excessive royalties, to carry their own new ideas forward as decentralized entrepreneurs in agricultural innovation. Such a clearinghouse functions to nurture in-country innovation over the import of relatively mature technologies.

Anna Sittenfeld of the University of Costa Rica, echoing a question posed earlier 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.

Arranging a general deployment of agbiotechnologies 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 exports to prevent unexpected fallout in other territories? Any clearinghouse agreement must look at specific technologies and specific products.

Richard Jefferson and others raised the importance of being precise when establishing criteria to implement such general policy for complex issues. He also 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 very 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. The development and introduction of biotechnologies for such regions are a special challenge, and likely 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, as new technologies evolve, 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.

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 gets a blanket research and commercialization license from DuPont without any reach-through restrictions automatically when they lease a gene gun. **June Blalock** concurred that a clearinghouse 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 a series of 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 it would be better able to induce individual inventors to contribute their patents into such a capability suite by offering an incentive of receiving 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, can then be added 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 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 about appropriate uses of the technology. This condition is due to their concern about both liability and negative publicity, and that the uses of the technologies do not compete with their paying customers.

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

Richard Jefferson expanded on the idea introduced in his presentation of equally sharing royalties within a reasonably small sized pool of inventions. This model is employed at CAMBIA and may be appropriate for IP pooling in a clearinghouse: 20 percent, for example, of the royalty revenues to a pool of patents is divided equally among the inventors of the constituent patents. Given this arrangement the inventors, on average, benefit from the licensing of other's inventions: as we have seen 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 each to further advance their individual income. 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 a 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 that their technologies be used for the public good.

In any of these scenarios, the choices of IP owners to make their technologies available are purely voluntary. While none of these mechanisms has the power to prevent IP owners holding up a technology commercialization for extortionary 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

IP education and capacity development:

There is much honest ignorance, especially in the 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, particularly of those in effect in developed countries, when in fact many technologies 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 have education and training as a component. In order to be successful it is important to develop basic IP awareness, IP management, and negotiating skills among the potential users. He speculated that if an IP trading or technology transfer mechanism were made available immediately to developing countries he is not sure they would even 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 developed countries on the potential benefits and biosafety hazards of biotechnology, to help them assess specific innovations that may be of value to their organizations. They also need to be educated in the importance of IP considerations and methods of accessing technologies that are especially relevant and useful to their industries through licensing and ownership of technology packages.

Patent law reform:

In response to questions, such as those raised in the first presentation of the morning 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 by pointing out that in the '80s it was very difficult to get a biotechnology patent and 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, and it has resulted in intellectual property protection becoming 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 reminded the workshop 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. Most of the applications are from foreign countries motivated in part because it is very inexpensive to patent in Costa Rica. To help handle the enormous job university faculty are making the reviews. 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 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 development of IPR regimes as well as biotechnologies is not done in a vacuum. Mechanisms to introduce technological capabilities and capacities to absorb knowledge are dependent upon and are affected by other policies and the development of other, related, capabilities. One of the most important features of the American system that needs to be emulated is its entrepreneurial spirit and the ability of individuals to modify their career choices and activities as well as to approach financial institutions to provide funding to take advantage of opportunities. Companies started by university professors and funded by venture capitalists 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 applications is 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 especially 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, among the emerging rules of the game in agricultural biotechnology, before IPRs there is a yet bigger concern: that of biosafety. GMO registration requirements--designed to test and approve safe biotechnologies for market--may indeed prove to be the greater barrier to the involvement of a more diverse set of players in the innovation and development of new biotechnologies and other agricultural technologies. 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 in IPR arrangements and could exercise economies of scale in 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:

- The international technology transfer deals modeled by ISAAA
- Plant royalty bureaus' funding of operations out of facilitated transactions
- Plant Biosciences Inc. licensing services
- The intellectual property design of the International AIDS Vaccine Initiative
- Successful university offices of technology transfer, such as Stanford
- CAMBIA's ability-to-pay licensing policy
- CAMBIA's equal-share inventor royalties policy
- The Patent and Licensing Exchange's symmetry of information provision, price discovery process, transaction management, and risk management functions
- Aurigin's Aureka analytical and information management systems

Next steps recommended from the floor of the roundtable discussion:

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

The participants at this workshop have been posed with a classic problem solving exercise. While there are clearly multiple overlapping problems and while it is beneficial to include as many potentially affected parties as possible in the discussion, any concrete institution building must be done on a clearly demarcated conceptual foundation.

- *Seek input from the potential clients of an IP clearinghouse, including particularly the national agricultural research systems of developing countries to assess what they would like to see and how they would be able to benefit from an IP clearinghouse.*

A clearinghouse for international agricultural development 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.

- *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 theory publicly available, in practice it is costly to get access and simply to search through the terabytes of data in the virtual information universe. Furthermore, it is important to know and to serve to the capabilities and needs of the various clientele, to serve them in finding, understanding, and organizing the right pieces of information in ways that will the right questions about complex technological developments which they may be interested in developing or acquiring and to give useful answers.

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

This recommendation for public organizations is based on the ideas of Alan Bennett and 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 a more transparent cross-licensing regime among themselves. CGIAR centers should 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 sets of clientele 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 in developing technologies and arrangements to gain access to IPRs. Since they have much in common, a common solution may serve both. Alternatively, however, there may need to be separate solutions for each of these sectors but which have some elements of collaboration. For example, universities and other public sector technology developers in the developed countries may share at least some knowledge and give limited IPR access for the development of tools to improve specialty crops. At the same time, for example, there may be significant value in pooling IPR and other knowledge assets in at least some groups of developing countries, allowing regional access to the knowledge and rights of private companies and universities.

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

For example, the similarity in small private firms' and universities' problems in accessing IP and their ability to manage IP and to pay modest royalties mean that perhaps the solutions for them can be contracted out and created by a private firm. The larger players in the developing world, such as Savia (ELM) in Mexico or Mayhco in India who have IP capacities and can pay royalties would also be able to use such a service.

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 funded agency would thus likely be needed to provide suitable IP solutions to them.

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

Dr. **Nir Kossovsky** offered the use of his company's software and systems for a simulation study of the exchange of agricultural biotechnology patents, to see what the IP being potentially offered on a clearinghouse looks like. Then, if reasonable input can be provided for what is being requested by technology buyers, a model simulation could analyze the extent to which the potential technology users' needs could be met by the patent exchange system.

- *Identify what specific technologies, particularly among the research enabling tools, are necessary and appropriate for an IP clearinghouse to deal in. Determine what conditions or stipulations of 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 mechanistic 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 perhaps 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 negotiate on their behalf with others? Would a central hub to such a network of sector-specific clearinghouses be appropriate to provide generalized services (a hub-and-spoke organization)? Would private investors be interested in backing such a venture? Would such a venture be viewed from the public sector 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 workshop. Others interested in such involvement or interested in being notified of follow up discussions or meetings are invited to contact the workshop organizers at:

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101 Giannini Hall
Berkeley, California 94720-3100
Phone: (510) 643-4200
Fax: (510) 642-4612 or (510) 643-4483 (backup)
Email: csrd@nature.Berkeley.edu
Website: http://www.CNR.Berkeley.EDU/csrd/

[i] Participants at the workshop came from the following organizations:

Aurigin Systems, Inc.
Calgene
California Agriculture Magazine
CAMBIA
Dow AgroSciences
DuPont
Farm Foundation
Cornell University, ISAAA
Island Press
Mendel Biotechnology
Meridian Institute
Michigan State University, Agricultural Biotechnology Support Program
Monsanto
Resources for the Future
Rockefeller Foundation
Rutgers University, Agricultural and Environmental Economics
Seminis Vegetable Seeds
Stanford University, Law School
The Patent and Licensing Exchange Inc.
Torrey Mesa Research Institute (formerly Novartis Agricultural Discovery Institute)
Tuskegee University, Plant Molecular Biology
UC Berkeley, Agricultural and Resource Economics
UC Berkeley, Center for Sustainable Resource Development
UC Berkeley, Economics
UC Berkeley, Environmental Science, Policy, and Management
UC Berkeley, Office of Technology Licensing
UC Berkeley, Plant and Microbial Biology
UC Davis, Agricultural and Resource Economics
UC Davis, Technology Transfer Center
UC Davis, Vegetable Crops
US Department of Justice, Antitrust Division, Economic Analysis Group
UC Office of the President, Office of Technology Transfer
University of Costa Rica, Plant Biology
University of Tel Aviv, Applied Economics
University of Wisconsin-Madison, Agricultural and Resource Economics
USDA, Agricultural Research Service, Office of Technology Transfer
USDA, Economic Research Service