Intellectual Property and Promoting R&D for the Public Interest in the Asian Region: Inclusionary and Distributive Innovation System Options

I. Introduction

There are important public needs to be addressed within the Asian region, such as degraded environments and their impact on health and the land productivity needed to support the population. Hundreds of millions of people in the region are chronically malnourished or suffer from the lack of reliable sources of clean water. While food production can be boosted by new farm technologies raising crop yields, inappropriate use of agricultural inputs can further degrade water and land to the detriment of further production. For example, global fertilizer use has gone up at least nine-fold in the decades since the 1950s, leading to significant contamination of surface and ground water and estuarine environments[1].

Another major problem exacerbated by the agricultural pressure is erosion[2], accelerated by significant deforestation and clearing of land purposely or through accidental fires; FAO estimates that 140 million ha of high quality soil, mostly in Africa and Asia, will be degraded by 2010 unless better methods of land management are adopted[3].

Thus, the carrying capacity of the region for human nutrition is actually decreasing. Furthermore, many countries of the region have large segments of populations living in various types of degraded and at-risk environments,[4] and the rapid increase in the human population and sources of degradation such as oil and mineral extraction, fuel stations and depots, transport terminals (particularly threatening waterways), refineries and chemical manufacturing installations, urbanizing areas lacking scaled-up sanitation, and increasingly intensive livestock production and crop fertilizer and pesticide use[5] has accelerated deposit of contaminants into soil and groundwater during the past several decades.

New inventions, particularly biological inventions such as new cultivars, propagation and breeding methods, and the innovation needed to bring them to effective utility, are clearly

[1] Saull, M. 1990. Nitrates in soil and water. Inside Science 37. New Scientist, Sept. 15.
[2] A joint study by FAO, the UN Development Programme (UNDP) and the UN Environment Programme (UNEP) of land degradation in South Asia, with details of the results available online at http://www.fao.or.th/Technical_Groups/Agriculture/agriculture.htm, found that water and wind erosion respectively damage 25 and 18 percent of the sub-region's total land, and that in China and Thailand, water erosion affects 34% of the land area.
[3] "Soil and Sediment Erosion" in Geoindicators, International Union of Geological Sciences, accessible at http://www.lgt.lt/geoin/doc.php?did=cl_soil
[4] Radio talk for World Health Day 2003 by Dr. Uton Muchtar Rafei, Regional Director, World Health Organization South East Asian Region, online at http://w3.whosea.org/en/Section980/Section1162/Section1167/Section1169_4683.html
[5] "DEAR - Vulnerable and Degraded Environments Assessment, Remediation and Management", Australian Research Council, online at http://www.vdearm.com/articles.php?rc=28

critical to take on these challenges, and thus it is imperative to foster enablement of innovators throughout the region. The question posed to us as a stimulus for this working group meeting is whether there are ways in which the intellectual property rights systems being put in place with the entrance into force of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement might constitute a stimulus or hindrance to public interest research and development. In response, we need to ask what types of research and development are actually needed to overcome these problems, whether IPRs stimulate or hinder those in particular, and whether and why compliance issues that might detract from their relevancy can be overcome.

II. How patent systems work

First let us look at intellectual property rights as an instrument of public policy. The foremost public policy justification for a strongly proprietary intellectual property system is that rewarding inventors with a limited term monopoly is a necessary incentive to obtain enabling written disclosure of inventions that are useful; without strong intellectual property rights (IPRs) to erect such competitive barriers, it is argued that useful inventions either would not be made at a sufficient rate, or would not be revealed to the public and therefore could not be as successfully commercialized and improved upon by innovators.

Thus, the TRIPS agreement provides that inventions must be disclosed by publication (Article 29), which in most countries must be sufficiently detailed to enable anyone of ordinary skill in the art to practice and use the invention; and sets out a minimum term for patent protection and remedies for the enforcement of intellectual property rights.

While the goals of the patent system are admirable, there are several problems inherent in entrusting it as the main instrument of public policy to foster or force disclosure of useful ideas.

First, the right that a patentee or holder of a patent license is able to enforce is not the right to use the invention, but only the right to exclude others from using the invention. The holder of patent rights may still be utterly unable to practice the invention if it depends on the use of or is dominated by patent rights held by another.

This is a problem because increasingly, important steps in product development are not self-contained, but instead interdependent, i.e. they may require several key component technologies to function. If not all such technologies are assigned to or held by a sole patentee, that patentee may not have freedom to operate. An owner of the rights to only one or a few of these technologies will have to acquire licenses to the rights of many others in order to actually make use of the inventions, and it is within the rights of any one patentee to exercise monopoly rights to deny others use of a patent by refusing to grant licenses. The result is a problem analogous to a wheel with multiple spokes. All the spokes must be intact if the wheel is to turn smoothly, and the absence of even one creates a flat that can stop the wheel from turning. Similarly, if a license is not available

to even a single one of the group of interdependent technologies, the owner of rights even to most of the rest of the component technologies will still not necessarily be able to use those rights to operate.

CAMBIA has built a unique dataset of over a million life sciences patents and a number of software tools for making the information in the patents more transparent[6]. Analysis shows many examples of interdependent groups of technologies in which denial of access to any single one technology can and does deny the use of the entire group of technologies by most potential users[7]. Thus, even a brilliant idea for an agricultural innovation that seems perfect to help many farmers will not necessarily do so.

This dilemma has an important side effect, that when particular areas of technology are "crowded" with patents for which licenses are not being made available, new inventions in those areas are unlikely to be usable. In such fields it is often not considered worthwhile for an inventor or technology owner to undertake the cost of patenting and to disclose an enabling description of a new technology. Thus, intellectual property rights actually begin to work in the opposite direction from the public policy goal they are intended to support, causing inventors to suppress their technologies rather than describing them.

Secondly, not all technology is protectable and therefore it is not the case that all types of technology development are encouraged by a patents system. In most patents systems, in order to qualify as patentable an idea must be novel and non-obvious over the prior art, and over combinations of what is known anywhere in the prior art. However, many of the innovations that are needed to convert an idea into a useful product would not be considered novel. Indeed, the pathway between a novel idea and a useful application may require a large number of critical developmental steps that are not incentivised by the patents system because they are combinations or adaptations of work that has been done elsewhere.

For example, let us suppose that an inventor develops a patentable method for making a new type of staple crop propagule that appears to be more water use efficient. A patent may be issued upon a single proof of concept or even upon an enabling prophetic description of the invention, but what are the steps likely to be required before this invention can be deployed?

- Improvements in the method may be necessary to achieve
    - Transfer of the new propagule type, which may require improved breeding methods, into additional varieties that may be more suited to different microclimates or more resistant to diseases
    - Multiplication of the propagule type, which may involve improved propagation methods, to cover the range of tests below
- Training methods for additional operators, efficiencies of scale, and methods for quality control may need to be developed to enable such multiplication.

[6] www.bios.net/ip
[7] For example, see www.bios.net/agrobacterium

- The new propagule may need to be field tested
  - in a number of different site types
  - with a variety of different edaphic (soil) conditions, and
  - with varying planting depths and stocking rates (spacing).

  Such testing may require years and can be very costly to carry out.
- In order to be used economically, the timing of expensive inputs such as
  - planting site preparation
  - irrigation,
  - fertilizers and
  - pesticides

  must be fine-tuned.
- Experimentation will often be required to determine
  - at what times of year and
  - how best to store and propagate the plant,
  - how to scale up production in time to meet seasonal deadlines,
  - rates of sustainable planting and harvest, and
  - how to harvest, store, and package the end product most economically.
- Phenotypic, phonologic and biochemical information may need to be collected and analysed to support regulatory processes
- Investors may require planning and research to determine
  - safety and palatability of the consumed product
  - any phytopathological, erosion, or cost implications of the altered planting practices
  - logistics of getting the product to the markets
  - resilience of the product supply to stochastic hazards such as typhoons
  - best market positioning relative to existing products that may be complementary, such as customary condiments, or competing
  - price-sensitivity

All this adaptation to make an invention usable may require intensive laboratory use and personnel, causing it to be very expensive, much more expensive than developing the original invention, but little of it would be patentable. Accordingly, investment in this sort of improvement and developmental adaptation would not be incentivised by the patents system.

Other incentives would be required to draw out such investment, primarily a large market pull, for example wealthy and demanding consumers for the prospective product and the possibility of high margins over the cost of goods sold. Under a scenario of low margins, in the absence of a large market pull and the promise of large returns on investment, the developmental investment needed to bring a product to deployment may never occur.

Indeed, if the situation of interdependent patents as noted above occurs, the patents system would actually discourage investment in such multi-step developmental adaptation toward commercial deployment, because lack of freedom to operate under license for a single aspect of the technology involved could block and destroy the worth

of the entire innovative process, while the iterative and cooperative shaping and improvement of the technology to meet diverse users' needs is unlikely to bring new patent assets into existence. Investors respond both to cost-benefit scenarios and to the perception of risk. Even if the initial investment costs might in some cases be low, investors are likely to undertake such a risk only if the eventual forecasted returns on that investment are very large. Thus, wherever patents could create a risk to freedom to operate, investment capital is even more unlikely to respond to weak market signals such as a market comprising the poor and the marginalized.

Thus, to foster inventions to respond to the needs of a market that is not wealthy and able to pull such significant investment, providing an incentive through the patents system for starting ideas is not enough. It may be as much or more in the public interest to incentivise and facilitate the multi-step improvement and product development process, which cannot be done solely through the patents system as presently defined.

The third limitation of considering the patents system as the main industrial policy to encourage invention is that there is considerable evidence that valuable invention can be encouraged in its absence. A great example is that historically, even in countries with a long patents tradition such as the USA, patenting has been less available for monopolistic protection of innovations in software; nonetheless software development has been greatly encouraged by the formation of "protected commons" for Linux software technology and many other software innovations. In this model, the source code arising from an inventor or technology owner is available to others connected within the commons via "open source" licensing (a license that allows anyone to improve and use the technology for making a profit, as long as they do not prevent others from using it). The protected commons differs from the public domain in that the users are constrained to certain conditions of use, but tens of thousands of users have agreed to these conditions under such license arrangements.

Despite the lack of exclusive protection such as that which would be offered by patents with limited license availability, there has been no obvious hindrance and indeed distinct accelerations are seen in the pace of innovation leading to improvements and commercialization. For example, IBM took in US$2 billion in revenues from services and innovations based on unpatented Linux code in 2003, more than double the revenues from outlicensing its own patents[8]. Furthermore, far from being discouraged in pursuit of commercial development by the lack of exclusive protection, investors like the lack of risk of being blocked from using the technology and improvements by the IPRs of others.

One reason for the success of the open source protected commons is that the ready availability of the license to use the inventive technology allows for a large number of creative minds to come up with improvements. No one company, not even a giant such as Microsoft, has a monopoly on all the best programmers, so this open source licensing allows improvements, even though they are not patentable, to be developed more quickly

[8] These data were compiled by Yochai Benkler from IBM annual reports and Forbes Magazine, http://www.forbes.com/forbes/2004/0607/086_print.html

than they would in a single company[9]. This open source improvements model, indeed, would be best applied in a situation where the number of potential contributors to improvements is large. In such a case, each participant in the protected commons pool receives not only the benefit of the inventions in the pool, but also a proportionately increasing value in accretive improvements.

The model has also flourished because of the distributive capability of the Internet and the power of informatics to foster transparency of improvements. Indeed, being able to share and display one's work distributively within the protected commons has developed a community feeling and community norms as a new type of incentive among the participants. In the open-source method, independent programmers around the world contribute, often without pay, to creating and honing better software such as the open-source Web server software Apache, which continues to dominate with 62% market share vs. 27% for Microsoft's software. The incentive is that the formation of a community feeling within the protected commons is tapping into the true motivation of programmers in a way that corporations often don't. "Programmers are like artists," says open-source software consultant Bruce Perens. At most corporations, their best work is hidden behind locked and guarded doors, when they would rather showcase their best work for their peers, as they can do in the open source protected commons.[10]

III. Solutions that mix new technologies with traditional advantages

Within the Asian region there is a dramatically wide spectrum in national implementation of industrial policy IPRs, enforcement standards, incentives for private investment in research and industry-research collaborations, and research exemptions. As these mechanisms, adapted to the historically capital-intensive investment requirements of basic R&D and innovative development in other regions, do not seem to be bringing about significant differences in the rate of implementation and improvements of inventions for public good goals in the Asian region, we suggest it will be profitable to discuss mechanisms that could remove barriers to or actually enhance publicly useful innovative disclosure, reduction to practice, commercialisation and improvement.

Ideally, in order to be better at empowering inventive and committed minds within the region to address both weak and strong market signals and public needs, these mechanisms should, rather than inexorably following the examples developed in quite different societies, take advantage of

- the traditional strengths of the regional cultures, and
- the region's large population,

factors that have been key to business models that have brought about lasting economic growth in the region.

[9] Commentary: Tech Outfits Should Take Notes. SPECIAL REPORT -- THE LINUX UPRISING, Robert D. Hof, Business Week, 3. March 2003
[10] *ibid*.

As described above, the ability to derive benefit from a large number of potential contributors and the more collaborative, connected mode of exploitation of intellectual property were both characteristics of the open source software protected commons model as it developed. The BIOS Initiative aims to build a legally and normative "protected commons" of biological intellectual property, on a precedent similar to that afforded by 'open source' software development, in which differentially motivated individuals, whether in for-profit or non-profit enterprises, can pool ideas and efforts safely and efficiently without any entity having the ability to hijack the whole.

By promoting new institutional mechanisms for licensing new technologies in a protected commons, BIOS will catalyse the empowerment of innovators throughout the region, whether located in rich or poor nations and institutions, to address local, small-margin, small market innovations in food, agriculture, public health, industry and environment. However, while it has its current business and social validation in the Open Source movement in information and communications technology, BIOS traces its roots back to practices of farmer-breeders in the first few thousand years of agricultural development, and finds elements of its motivations in the powerful drive to share the results of scientific endeavour that has characterized the best of science over the last four hundred years.

To encourage this motivation, the timing is perfect to take advantage of the communications and data transfer opportunities of the internet to build useful information connections between problem solvers and technology owners. The ability to build collaborative, license-protected websites has enabled inclusionary, distributive innovation system reform options for software innovation, and it is the aim of the BIOS initiative to adapt the same inclusionary, distributive means to enabling biological innovators.

We will need to use sophisticated informatics to increase transparency and to get around language barriers, but our aim is that the user interfaces not reflect these complications, but instead are readily accessible, with the goal to stimulate mechanisms to incentivise and coalesce creative solving of problems. A scenario is as follows:

Imagine an inventive problem solver in a small regional university, public institute or SME-type company in India or Vietnam. This individual, usually with modest or no financial resources, may perceive a problem or be charged with solving a problem of localised relevance, perhaps a new disease challenge to crop production or a new public health challenge.

An idea about how to approach a solution may already be formed in this person's mind, or perhaps not; perhaps the individual feels overwhelmed by the enormous responsibility and lack of resources. How can he or she find the energy, knowledge, toolkit and capacity to explore potential solutions and adapt and shape them for this local problem? What will be the mechanism for delivery – a problem whether the individual is in public or private enterprise? How can a sustainable contribution to that solution be ensured?

This inventor will almost certainly have access to the internet, as such access is increasing exponentially in the region and will within ten years be virtually ubiquitous with affordable high bandwidth. Thus it will be possible to go to the BioForge website, which will be constructed by CAMBIA's BIOS Initiative, and there to search many categories of problems being tackled by countless groups and individuals. The local researcher can readily find a user group or groups with some synergies to the problem she faces. If such a group doesn't exist, there will be an easy software mechanism to form one, and place a call to the community to help structure such a group.

Without limitations related to time zones, members of the worldwide research community can find opportunities to volunteer an hour, a day, a week of their time, confident that each contribution may have a high probability of making a difference. A graduate student in Europe or the US or a technician in Bangladesh or New Zealand can access the website in spare time, find this project, and offer some assistance, however small or large, that may be germane to solving the problem.

The website is intended to comprise, as the BIOS IP tools currently do, databases navigable by the neophyte, allowing queries about what worldwide progress in the public or proprietary domain has already been made that could be relevant. Has the idea already been appropriated in the proprietary domain, or otherwise restricted by patents in relevant jurisdictions? Are there ways to manoeuvre within the IP constraints and find technical and legal means forward? Does the ability to solve the problem reside in already published patents that are not filed in the local jurisdiction, or that have been allowed to lapse? Will it be necessary to re-invent the wheel? The ability to interpret and filter this massive information load will have to be provided by a culturally friendly interface, behind which are located powerful informatics aids to guide queries in a way that is helpful to build on the local investigator's knowledge and needs.

If a group with a similar or compatible goal already exists on the website, there will be a simple means to access the expertise, and a guarantee – by the site's operating charter and the license to which all site users must agree – that such access to the fruits of the group's labours can be made without fear that the access will be removed when a product is developed and ready for deployment. It will be possible to surf and work within this site filled with biological innovators, secure in the knowledge that this community is based on a premise of sharing the tools and improvements that are developed, and licenses that guarantee the right to reduce the collective contributions to commercial practice.

This confidence can be shared by local investors – public or private – who can be encouraged that a development based on and leveraging the open-source community can have real critical mass for improvement and testing, and legal precedent for delivery. This investment will be extremely valuable to ensure a sustainable resource base to implement, test, learn from, revise and ultimately deliver and support the innovation in the local region. Small local enterprise can form around this innovation, not beholden to third-party rights, with the confidence that if it is successful it might later be able to trade the products or services that flow on from its development efforts on a national, regional

or even international scale through the freedom to operate offered by the license covenant not to sue.

Perhaps the most significant advantage of the envisioned community is the power of the norms that will be created by the connectivity and collaboration to solve local problems in a locally appropriate way. Many of the technologies available for remediation of contaminated land and water are imported from the U.S. and Europe, and methods of implementation are based on information borrowed from the U.S. and Europe, resulting in troublesome uncertainties when attempts are made to apply them at sites whose characteristics are different.[11] Asia-Pacific farms account for more than half of the world's agricultural water use with 60 percent of the world's water being consumed in the region in the year 2000, but the same FAO study cited above pointed out a similar failing in irrigation systems whose specifications were tailored to the conditions of decades ago in the US and Europe, that their use in Asia tends to be not only costly, but also inefficient: it was estimated that up to 60 percent of the water diverted or pumped for irrigation in Asia is not successfully directed to plant production.[12] It is not only failure to implement technologies in ways that are appropriate to the local conditions, but also compliance failures that result in remediation difficulties. Two examples: while several Southeast Asian countries have adopted policy frameworks for sustainable forest management (e.g. Malaysia's National Forestry Act of 1984) to decrease deforestation and thus erosion, these are only spottily enforceable. Secondly, deposit of contaminants into soil and groundwater by industry and municipalities has scarcely been slowed by legislation in the past 15 years in many Asian countries, because of lack of adherence to the regulatory criteria.[13] Compliance problems tend to be a symptom of a lack of ownership of laws, policies, regulations and norms, based on failure to understand their personal importance or benefit, or a lack of fit with the local culture. The best way to solve problems like these is to employ the creative minds at the local level who are committed by virtue of their ownership in local problems and local culture. The BIOS initiative aims to use the distributive technology and formation of community norms empowered by the Internet to encourage local ownership in locally appropriate applications of technology.

Though it is not entirely in place as yet, the above-described scenario requires nothing that is fanciful or without precedent. The community of goodwill that exists in the world biological scientific community cannot be doubted. The legal and business precedents are strong, as manifested by the extraordinary success and momentum of the open source software community. The software and informatics that must be created and harnessed

[11] "DEAR - Vulnerable and Degraded Environments Assessment, Remediation and Management", Australian Research Council, online at http://www.vdearm.com/articles.php?rc=28

[12] From a joint study by FAO, the UN Development Programme (UNDP) and the UN Environment Programme (UNEP) of land degradation in South Asia, with details from the results described online at http://www.fao.or.th/Technical_Groups/Agriculture/agriculture.htm

[13] "DEAR - Vulnerable and Degraded Environments Assessment, Remediation and Management", Australian Research Council, online at http://www.vdearm.com/articles.php?rc=28

are manageable. The communications paradigms and opportunities are in place and growing indisputably even into the most economically neglected communities.

IV Summary

We have seen that encouragement of biological innovation is essential for all aspects of social and economic development in Asia, and that intellectual property rights were designed to encourage and support innovation, but also that the patents system is neither necessary nor sufficient for such encouragement, and can actually work against it.

We have seen that TRIPS assumes investment will come when inventors are rewarded, but doesn't incentivise what are perhaps the most important and certainly the most expensive parts of product development for deployment.

We have seen that inventors are not always capable of bringing their inventions to production and markets (due to lack of capital and other factors). The prevention of use by others of an invented technology subject to IPRs can backfire by making it even more difficult for innovators to make further improvements on the technology, such as process efficiencies, that could then add to its public value by bringing it to commercialization and/or responding to public needs.

We have seen that to empower inventive and committed minds within the region to address both weak and strong market signals and public needs, intellectual investment mechanisms will be needed that are collaborative and appropriate to the region's large population rather than capital-intensive.

We have seen that the time is uniquely appropriate for using the communications and data transfer opportunities of the internet to build useful information connections between problem solvers and technology owners in an inclusionary, distributive innovation system.

We have seen that the open source software protected commons model has been useful for spurring investment and rapid innovation. Similarly the BIOS Initiative aims to build a legally and normative "protected commons" of biological intellectual property in which differentially motivated individuals, whether in for-profit or non-profit enterprises, can pool ideas and efforts safely and efficiently without any entity having the ability to hijack the whole. This should enable incentivising and coalescing a creative process of solving problems locally with technology accessed globally.

Lesser-developed countries of the region that desire to support inclusionary and distributive innovation using a paradigm such as this can assist by making patents databases available, commonly formatted and transparent; by recognising and encouraging open source licensing and the legal frameworks of protected commons; and by facilitating access to the BioForge by individuals in universities and research institutes who can assist with translation and access of the ideas on behalf of their local

communities and the micro, small and medium enterprises functioning in those communities.

V. Acknowledgements:

The preparation of this paper was funded by the Centre for the Application of Molecular Biology to International Agriculture (CAMBIA), Australia, through a consultancy. The header did not provide a space for the listing of co-authors, but this paper embodies the creative ideas of my co-author Richard Jefferson. Funding for the BIOS Initiative is provided by the Rockefeller Foundation. Equipment for website development has been provided by IBM. Funding for travel to allow me to attend this conference, at the kind invitation of Johanna Braun of ICTSD, was generously provided by IDRC.