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The Impact of Intellectual Property on Nonprofit Research Institutions and the Developing Countries They Serve

Ronald P. Cantrell

Gene P. Hettel

Gerard F. Barry

Ruaraidh Sackville Hamilton

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Ronald P. Cantrell, Gene P. Hettel, Gerard F. Barry, & Ruaraidh Sackville Hamilton*

I. TECHNOLOGICAL INNOVATION IS ESSENTIAL FOR HUMAN PROGRESS

Technological innovations, inside or outside of agriculture, are essential for human progress.[1] These innovations have driven social and economic development over the centuries. From the first use of vaccines to the widespread use of penicillin, from the printing press to the computer and Internet, and from early farmers' selection of seeds to the advent of the Green Revolution,[2] people have devised tools for improving health, facilitating learning and communication, and raising agricultural productivity.

The International Rice Research Institute (IRRI) agrees with the assessment of the United Nations Development Programme, as articulated in its *Human Development Report 2001*, that "technological advance has contributed greatly to the acceleration of human progress in the past several centuries,"[3]

* International Rice Research Institute. Director General; Head, Communication and Publications Services; Coordinator, Golden Rice Network; and Head, Genetic Resources Center, respectively.

1. *See* Farmers Reservoir & Irrigation Co. v. McComb, 337 U.S. 755, 761 (1949), *cert. denied*, 338 U.S. 839 (1949) (providing examples of necessary technology in agricultural history).

2. The term "Green Revolution" describes the success in increased crop production, commencing in the 1960s as a result of high-yielding rice varieties developed by the International Rice Research Institute (IRRI) and wheat varieties by the International Maize and Wheat Improvement Center (CIMMYT).

3. UNITED NATIONS DEV. PROGRAMME, HUMAN DEVELOPMENT REPORT 2001: MAKING NEW TECHNOLOGIES WORK FOR HUMAN DEVELOPMENT (2001), http://hdr.undp.org/reports/global/2001/en/pdf/front.pdf (last visited Nov. 15,

and that "[t]hose contributions have the promise of even greater acceleration."[4] As technological breakthroughs of the past have improved human health and nutrition, expanded knowledge, and stimulated economic growth, IRRI is confident that the genetic, molecular, and digital wonders of today will alleviate poverty in the developing world.

IRRI also agrees with C.S. Prakash and Gregory Conko, who point out that "[c]ountries that embraced superior agricultural technologies have brought unprecedented prosperity to their people, made food vastly more affordable and abundant, [and] helped stabilize farm yields."[5] During the last 50 years, productivity gains allowed the world's farmers to double global food output on roughly the same land area, but at the same time global population rose by more than 80 percent.[6] Prakash and Conko observe that "[w]ithout these improvements in plant and animal genetics and other scientific developments, known as the Green Revolution, we would today be farming on every square inch of arable land to produce the same amount of food, destroying hundreds of millions of acres of pristine wilderness in the process."[7]

IRRI believes access to new technologies plays a crucial role in helping the developing world's poor break out of the poverty trap that has ensnared them since before the Green Revolution. Indeed, it is important that IRRI locate inventive ways to ensure that intellectual property policies and laws will not adversely affect Third World access to global public goods, such as those produced by universities in the United States land-grant system and research centers associated with the Consultative Group on International Agricultural Research (CGIAR).

To address such issues, Parts II and III of this paper examine the ever-changing field of intellectual property rights and how it affects germplasm policy. Part IV discusses the specific needs developing countries have with regard to intellectual property. Finally, Parts V and VI explore how

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4. *Id*.

5. C.S. Prakash & Gregory Conko, *Technology That Will Save Billions from Starvation*, AGBIOWORLD.ORG, Mar. 1, 2004, *at* http://www.agbioworld.org/biotech_info/articles/prakash/prakashart/save-billions.html.

6. *Id*.

7. *Id*.

these particular issues influence the modes in which agricultural technologies are supplied to developing countries.

II. INTELLECTUAL PROPERTY RIGHTS ARE HERE TO STAY

Ronnie Coffman, Susan McCouch, and Robert Herdt of Cornell University contend that intellectual property rights are here to stay and globalizing rapidly.[8] Most key inventions in food and agricultural occurred, and will continue to occur, at public-sector research universities.[9] They assert that public funding must maximize public benefits, and maintain that food security is certainly an important public benefit.[10] Accordingly, it is argued that international agricultural research centers, such as IRRI, and national agricultural research systems, located in India, China, Brazil, and throughout the developing world, need access to intellectual property rights.[11] Although the private-sector will never directly serve poor farmers, private companies possess intellectual property rights that they are willing to donate and pool to create added value.[12] IRRI concurs that most university scientists would enjoy seeing their work benefit the indigent. A portfolio of public intellectual property rights supplemented with case-by-case licensing can provide both freedom to operate and benefits to humanity through sharing.

Contrary to popular argument, the main purpose of intellectual property rights is neither to provide financial protection to those investing in product development, nor to encourage research into new technologies.[13] While these are

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8. *See* Ronnie Coffman, Susan R. McCouch & Robert W. Herdt, Potentials and Limitations of Biotechnology in Rice, Presented at the FAO Conference on Rice in Global Markets and Sustainable Production Systems (Feb. 2004) (asserting the statement as an assumption), *at* http://www.fao.org/rice2004/en/pdf/coffman.pdf (last visited Sept. 22, 2004).

9. *Id*.

10. *Id*.

11. *Id*.

12. *Id*.

13. *See* Gregory Conko, *GMO Patents Played Out*, CHECKBIOTECH.ORG, Jan. 27, 2004, *at* http://wwwcheckbiotech.org/root/index.cfm?fuseaction=news&doc_id=7023&start=31&control=156&page_start=1&page_nr=101&pg=1; *see also* United States v. Paramount Pictures, Inc., 334 U.S. 131, 158 (1948) (analogizing copyright law to patent statutes, whereby the primary motive of such laws is to serve the public over rewarding the author), *remanded to* 85 F. Supp. 881 (S.D.N.Y. 1949); Sinclair & Carroll Co. v. Interchemical Corp., 325 U.S. 327, 330-31 (1945) (stating that the primary

valuable outcomes, they are not the primary goals. According to Gregory Conko, "the chief purpose of patent laws has always been to encourage the dissemination of information so that new technological knowledge could be introduced into the public domain more quickly."[14] IRRI agrees with this proposition. Even so, recent changes in intellectual property have drastically affected how the Institute works.

Information dissemination is realized, in part, by requiring patent-seeking inventors to provide a written description of the invention and the underlying creative process so that any person skilled in the field can verify the claimed invention and reproduce the technology once the patent expires.[15] Section 112 of the Patent Act provides:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.[16]

This requirement "is the root of all patent systems and, combined with the financial rewards of intellectual property protection, has tended to accelerate the movement of new technologies into the public domain, not impede it."[17]

Of all human endeavors, agriculture places the most pressure on land, its resources, and biodiversity.[18] Over the past 50 years, increase in food production has resulted in the loss or movement of one-fifth of the world's topsoil, one-fifth of its agricultural land, and one-third of its forests.[19] To slow down and ideally reverse this trend in the face of not only a predicted population increase of 50 percent, but also water

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purpose of the patent system is to benefit society, not reward the individual).

14. Conko, *supra* note 13.

15. *See id.*

16. 35 U.S.C. § 112 (2000); *see also* W.L. Gore & Assocs. v. Garlock, Inc., 721 F.2d 1540, 1556 (Fed. Cir. 1983) (clarifying that the inventor must set out the best mode for the invention known at the time of the patent, and that the patent is only meant to enable those already skilled in the field), *cert. denied,* 469 U.S. 851 (1984); *In re* Howarth, 654 F.2d 103, 105-06 (C.C.P.A. 1981) (reiterating that 35 U.S.C. § 112 (2000) requires a full representation of the invention, and that subsequent readers of the patent must have ordinary skill in the art).

17. Conko, *supra* note 13.

18. *See* Andrew Cockburn, *Commercial Plant Breeding: What Is in the Biotech Pipeline?*, 10 J. COM. BIOTECHNOLOGY 209, 209 (2004).

19. *See id.*

shortages and climate change, biotechnology must play a leading role in agricultural development.[20]

This article discusses intellectual property rights as they relate specifically to biotechnology and genetically modified organisms (GMOs) used as tools to achieve sustainable improvement of crop and livestock productivity, to enhance human and animal health, and to develop renewable resources. Much of what IRRI and other research organizations produce still involves conventional technologies. Intellectual property regimes for some of these humanitarian non-GMO technologies, such as a new kind of irrigation pump or a specialized tractor, remain unaffected. However, intellectual property concepts, particularly for crop germplasm, changed dramatically in recent years and will continue to change. Nevertheless, this change in intellectual property does not impair the developing world's access to technology for humanitarian purposes.

III. IRRI'S INTELLECTUAL PROPERTY POLICY ON GERMPLASM

IRRI's primary clients are the national agricultural research and extension systems (NARES) of developing countries, which, in turn, serve poor farmers within their borders.[21] It is useful to show how IRRI adjusted its policies on germplasm in response to the recent evolution of intellectual property.

A. BEFORE 1993

Historically, IRRI's intellectual property policy for germplasm was simple, driven by its mission to "improve the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes."[22] As part of this mission, IRRI produced and disseminated rice germplasm and knowledge without restraint as global public goods, in a manner readily accessible to the poor.[23] In 1975, the

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20. *See id.*

21. *See generally* IRRI Genetic Resources Center, *IRRI's Policy on Intellectual Property Rights,* at pmbl. ("Whereas IRRI wishes to bring to the developing nations and particularly to low income rice farmers in these nations the benefits of the most advanced biological technologies"), *at* http://www.irri.org/GRC/requests/ipr-policy.htm (last visited Sept. 7, 2004).

22. IRRI, *IRRI's Mission Statement*, *at* http://www.irri.org/about/mission.asp (last visited Sept. 7, 2004).

23. *See generally* IRRI Genetic Resources Center, *supra* note 21 (stating

Institute stopped releasing so-called IRRI varieties altogether. Instead, it allowed NARES to choose among IRRI's best advanced lines and encouraged them to commercialize the material as their own varieties in their own countries. Pursuant to its policy, IRRI did not claim intellectual property rights on germplasm it developed or held in its genebank. The Institute does not own this germplasm, but rather holds it in trust with the responsibility to conserve, maintain, improve, and distribute it for the benefit of global agricultural research.[24]

B. CONCEPTUAL CHANGES IN INTELLECTUAL PROPERTY

Changing concepts and increasing global sensitivities over intellectual property in crop germplasm influenced the evolution of IRRI's intellectual property policy. For example, the Convention on Biological Diversity (Biodiversity Convention), held in Rio de Janeiro on June 5, 1992, changed the status of plant genetic resources from a global heritage of mankind to an appropriate subject of national sovereignty and intellectual property rights.[25] It diluted fundamental tenets of the CGIAR, specifically that the unrestricted free exchange and exploitation of plant genetic resources are acceptable activities to alleviate poverty.[26] As another example, the 1983 International Undertaking on Plant Genetic Resources for Food and Agriculture, revised in 1989, 1991, and 1993, began with early guidelines for the fair collection of germplasm.[27] The Undertaking later introduced the concept of "In Trust" germplasm collections with obligatory defensive material transfer agreements (MTAs), in an attempt to retain the status of plant genetic resources in CGIAR genebanks as global public

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that IRRI desires free international flow of its resources).

24. *See id.* (explaining that IRRI will continue to make genetic resources that it holds in trust freely available).

25. *See United Nations Conference on Environment and Development: Convention on Biological Diversity*, 31 INT'L LEGAL MATERIALS 818, 824 (1992) (articulating that states have the sovereign right to exploit their resources in accordance with their own policies).

26. *See generally id.* at 830-31 (emphasizing the role of financial mechanisms and schemes between parties).

27. *See*, *International Undertaking on Plant Genetic Resources*, Res. 8/83, U.N. Food and Agric. Org., 22nd Sess. (1983) (giving guidelines for the exploration of plant genetic resources, including taking special care in areas where plant species are in danger of extinction), *available at* ftp://ext-ftp.fao.org/ag/cgrfa/iu/iutextE.pdf (last visited Nov. 17, 2004).

goods,[28] despite the Biodiversity Convention's changes. The International Treaty on Plant Genetic Resources for Food and Agriculture, which recently came into force, is an intergovernmental agreement on the exchange of germplasm in harmony with the Biodiversity Convention.[29] It introduces additional changes requiring even more corresponding adjustments to IRRI's intellectual property policy.

Because of these legal developments, IRRI needs to form partnerships with the private-sector and to claim ownership of intellectual property it develops. It also must demand transparency and accountability, both to demonstrate that it is not misappropriating germplasm and to prevent the misappropriation of germplasm by others. Indeed, IRRI must respond to these changes without compromising its primary mission of enhancing the livelihoods of the poor through sustainable improvement in rice farming. The Institute still seeks to produce and disseminate germplasm and knowledge with the fewest constraints possible, but only with due respect for the rights of other individuals, organizations, and nations under the new international agreements.

C. CURRENT STATUS

IRRI updated its policies and working practices on intellectual property and germplasm to conform fully to existing international agreements and to the expectations of its NARES partners in the developing world.[30] For the distribution of In Trust germplasm, as requested by the Food and Agriculture Organization (FAO) Commission on Genetic Resources for Food and Agriculture, and as approved by the IRRI Board of Trustees, the Institute now utilizes a new Interim MTA. IRRI seeks to ensure that the terms and conditions of the Interim MTA are legally enforceable. The Institute also implemented a single gateway for germplasm

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28. *See generally* Food and Agriculture Organization, *A Treaty on Plant Genetic Resources*, AGRICULTURE 21 (Dec. 2001) (discussing the role of MTAs), *at* http://www.fao.org/ag/magazine/0112sp3.htm (last visited Nov. 14, 2004).

29. *See Adoption of the International Treaty on Plant Genetic Resources for Food and Agriculture and Interim Arrangements for Its Implementation*, *at* ftp://ext-ftp.fao.org/ag/cgrfa/res/c3-01e.pdf (Nov. 3, 2001); International Treaty on Plant Genetic Resources for Food and Agriculture, *entered into force* June 29, 2004, *available at* ftp://ext-ftp.fao.org/ag/cgrfa/it/ITPGRe.pdf.

30. *See* IRRI Genetic Resources CenterCtr, *How IRRI Distributes Germplasm*, *at* http://www.irri.org/grc/requests/distribution_policy.htm (last visited Sept. 7, 2004).

into and out of IRRI to ensure that all its scientists comply with all legal obligations, even if not personally aware of them. All incoming and outgoing seed is now accompanied by an appropriate MTA. In addition, IRRI is upgrading the International Rice Information System to improve the handling of intellectual property rights and to increase transparency.

For the distribution of IRRI-bred germplasm, IRRI has developed a second MTA, also defensive in nature, allowing the Institute to distribute improved germplasm without restrictions while also protecting against misappropriation by other parties. For the distribution of germplasm bred by or with NARES partners, IRRI negotiated a "third-party" MTA.

Further international agreements will require even more changes to IRRI policies. For example, the International Treaty on Plant Genetic Resources for Food and Agriculture, discussed previously, came into force on June 29, 2004.[31] This treaty will eventually require the adoption of a new standard MTA to be used by all contracting parties and CGIAR centers. New agreements to be signed with CGIAR centers will replace the current agreements with the FAO and establish procedures for handling different classes of germplasm.

D. IRRI'S INTELLECTUAL PROPERTY PHILOSOPHY FOR THE FUTURE

IRRI is as committed to its intellectual property strategy as it is motivated to provide germplasm to all without restrictions. The overriding question is whether the Institute can still serve the poor with top-quality, proven science, patented or not, rather than unprotected, less proven, and inferior technology that takes longer to develop. The answer seems clear. If IRRI does not exploit new and cutting-edge technologies, patented or not, the Institute becomes less relevant to both donors and NARES. In addition, IRRI could face difficulty in attracting and keeping top scientists and risk wasting resources trying to find alternative solutions. Inevitably, IRRI should seek more licenses to needed new technologies, provided that those licenses neither undermine the Institute's mission nor compromise benefits to clients.

To ensure success, IRRI is monitoring the international intellectual property landscape and scrutinizing every item adopted into the Institute's research programs for intellectual

31. *See* International Treaty on Plant Genetic Resources, *supra* note 29.

property issues. Moreover, IRRI strives to ensure that its internal intellectual property management unit is functioning efficiently and effectively. In addition, the Institute is implementing impeccable standards for handling intellectual property and instituting routine internal audits on technology in use.

Even with the foresight to survey the landscape and to put forward-looking intellectual property measures in place, intellectual property management and planning is a continuous and daunting process. For example, if genes initially not known to carry patents are later patented, IRRI may face obstacles in releasing products developed with the genes. In this situation, IRRI and its NARES partners would need to acquire the proper licenses and ultimately risk project abandonment. Any mistakes would waste scarce resources and undermine the Institute's credibility with both NARES and donors.

In order to sustain credibility, IRRI places significant emphasis on training for intellectual property-related issues, both in-house and with NARES partners. For example, the Institute is expanding a training program on intellectual property in plant genetic resources for the NARES at all institutional levels, from policy developers and managers to scientists. Further expansion is expected to involve collaboration with the International Plant Genetic Resources Institute (IPGRI) in regionalizing a new training course.[32] IRRI anticipates that such capacity-building will strengthen the confidence of NARES partners, eventually encouraging them to exchange germplasm again, under the protection of the new MTAs.

In recognition of these new challenges, IRRI utilizes policies not only for germplasm management but also for engineering and software innovations and intellectual property in general. These policies require links with the private-sector, an area where IRRI believes it retains an important role as an unbiased broker in technology development and transfer among various public institutions, as well as between such public institutions and private-sectors.

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32. *See* Int'l Plant Genetic Res. Inst., *Training*, *at* http://www.ipgri.cgiar.org/system/ page.asp?theme=9 (last visited Sept. 7, 2004).

E. NARES ACCESS TO GMOS

Using biotechnology and GMOs to improve crop germplasm is a critical issue. The current complexities of the regulations surrounding the release of GMOs into agriculture and food chains are well known.[33] At the same time, IRRI must respond to NARES partners who wish to take advantage of these technological breakthroughs. Fortunately, the private and the public sectors, in both developed and developing countries are screening a large number of transgenes, moving valuable ones through field trials toward products. The Institute can monitor these advances and commit itself to develop only carefully selected transgenic varieties upon clarification of biosafety and intellectual property license issues. IRRI may then distribute these products only to NARES partners who themselves have developed nationally approved biosafety and intellectual property guidelines.

IV. DIFFERENT DEVELOPING COUNTRIES HAVE DIFFERENT INTELLECTUAL PROPERTY NEEDS AND CAPACITIES

The terms "Third World" and "developing country" are nets that capture fish of all sizes, from nuclear powers with extensive commercial agricultural production systems and sophisticated agricultural research capacity, to rural countries with rather limited research capacity or those on the brink of starvation. IRRI must differentiate these categories. A one-

33. *See*, *e.g.*, THOMAS BERNAUER, GENES, TRADE, AND REGULATION: THE SEEDS OF CONFLICT IN FOOD BIOTECHNOLOGY 44-65 (2003) (describing regulations of genetically engineered products); Rebecca Bratspies, *The Illusion of Care: Regulation, Uncertainty, and Genetically Modified Food Crops*, 10 N.Y.U. ENVTL. L.J. 297 (2002) (arguing that much uncertainty surrounds the future of genetically modified crop regulations); Marsha A. Echols, *Food Safety Regulation in the European Union and the United States: Different Cultures, Different Laws*, 4 COLUM. J. EUR. L. 525 (1998) (articulating the differences in food safety regulations between the U.S. and the E.U.); Michael P. Healy, *Information Based Regulation and International Trade in Genetically Modified Agricultural Products: An Evaluation of the Cartagena Protocol on Biosafety*, 9 WASH. U. J.L. & POL'Y 205 (2002) (discussing the regulation of international trade in genetically modified agricultural products); Sophia Kolehmainen, *Precaution Before Profits: An Overview of Issues in Genetically Engineered Food and Crops*, 20 VA. ENVTL. L.J. 267, 288-93 (2001) (describing the regulatory structure of genetically engineered food and crops in the U.S.); Aarti Gupta, *Governing Trade in Genetically Modified Organisms: The Cartagena Protocol on Biosafety*, 42 ENV'T No. 4, 22 (2000) (describing an international agreement concerning the regulation of the transboundary transfer of GMOs).

size-fits-all approach to intellectual property is neither feasible nor desirable for countries with different needs and capacities. What is best for one country is unlikely best for all others.[34]

Intellectual property has different effects in different contexts. In some situations, as in many African countries, the conditions in which intellectual property might be expected to play a positive role do not exist. Some view intellectual property rights and patents as tools to promote innovation and encourage the dissemination of information, while others dismiss them merely as tools to capture market share. Regardless, in many developing countries, intellectual property plays neither role, as markets for innovation and a sizable capacity to innovate do not exist. Many developing countries also lack legal, scientific, and administrative capacity to enforce intellectual property.

Additionally, intellectual property rights are national in character as intellectual property rights granted in one country do not automatically apply in others unless specific steps are taken to secure the rights.[35] Unless a country is constrained by commitments made in international treaties such as the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS),[36] one country may ignore the patent laws of another. In some cases, this increases access to technologies. In other cases, it makes patent holders reluctant to release their products, ultimately decreasing access. IRRI must remain cognizant of these subtleties if it wants to play the role of broker among public and private institutions.

Wherever practicable, intellectual property policy should not restrict the flow of information. As stated earlier, innovation is essential for economic and social progress, and intellectual property plays an important part in achieving these

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34. *See* The Royal Soc'y, *Keeping Science Open: The Effects of Intellectual Property Policy on the Conduct of Science* (Apr. 2003), *at* http://www.royalsoc.ac.uk/files/statfiles/document-221.pdf (copy on file with author); Personal communication with Cary Fowler, Centre for International Environment and Development Studies, University of Norway (2004).

35. Personal Communication, *supra* note 34.

36. *See* Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, LEGAL INSTRUMENTS - RESULTS OF THE URUGUAY ROUND 33 I.L.M. 81 (1994) [hereinafter TRIPS Agreement], *available at* http://www.wto.org/english/tratop_e/ trips_e/t_agm0_e.htm (last visited Oct. 14, 2004).

goals. The Institute endorses a key recommendation of the U.K. Royal Society, "that [intellectual property] policy should be formulated to minimise [sic] any negative effects on education and the scientific endeavour [sic] whether in industry, [Public Sector Research Establishments] or universities."[37] As an organization involved in research, IRRI must closely assess the extent to which intellectual property rights directly or indirectly inhibit the free flow of information.

A. SOME EXAMPLES

Intellectual property affects the flow of technologies to developing countries. For instance, Brazil has both local institutions and international private-sector companies that interact according to a classic distribution technique. The Brazilian NARES, EMBRAPA (Brazilian Agricultural Research Corporation), develops maize inbreds and licenses them to a "club" of private companies.[38] Different members of the club receive EMBRAPA inbreds in a given year, throughout which they have exclusive use. In this respect, EMBRAPA is using a classic technique for distributing germplasm in the developing world. Changes in the recognition of intellectual property in germplasm seemingly make little difference in Brazilian maize improvement.

In India, the Maharashtra Hybrid Seed Company (Mahyco) bills itself as a producer and marketer of seeds developed with the latest advances in biotechnology.[39] Still, the absence of intellectual property rights forces the company to deal solely with hybrid crops and vegetables. With hybrids, years elapsed before others could take advantage of what Mahyco developed.[40] Suppliers of agricultural technology must meet these challenges.

V. SUPPLIERS OF AGRICULTURAL TECHNOLOGIES TO THE DEVELOPING WORLD

Suppliers of agricultural technologies to developing countries fall into four categories across the public and private

37. The Royal Soc'y, *supra* note 34.

38. *See* EMBRAPA, *Programs & Projects, at* http://www.embrapa.br/english/ projects/index.htm (last visited Sept. 9, 2004).

39. *See* MAHYCO, *Welcome to Maharashtra Hybrid Seed Company*, *at* http://www.mahyco.com (last visited Sept. 3, 2004).

40. Personal communication with Usha Barwale, Maharashtra Hybrid Seed Company, Chennai, India (2004).

sectors: national public, national private, international public, and international private. All of the institutions and companies listed in Table 1 function within intellectual property systems, either real or anticipated. Moreover, these actors are driven by the desire to maintain good relations with donors, customers, and other stakeholders. As pointed out in the U.K. Royal Society Report, intellectual property affects these suppliers.[41] Their research, whether independent or collaborative, should be of value to the other suppliers. If intellectual property policies are to maximize benefits for humanity, then entities in each sector must be sensitive to the aspirations and needs of those in the other sectors.[42]

TABLE 1. INSTITUTIONS, ORGANIZATIONS, AND COMPANIES ACROSS THE PUBLIC AND PRIVATE SECTORS THAT SUPPLY TECHNOLOGIES TO AND WITHIN DEVELOPING COUNTRIES.[43]

National public
NARES
- Philippine Rice Research Institute (PhilRice) (www.philrice.gov.ph)
- National Centre for Plant Genome Research (http://dbtindia.nic.in/institutions/ncpgr.html)
- Jawaharlal Nehru University and the Central Rice Research Institute at Cuttack, India (http://ricecuttackindia.tripod.com)
- Ubon Rice Research Center (URRC) in Thailand.
- Brazilian Agricultural Research Corporation (EMBRAPA) (www.embrapa.br).
- China National Rice Research Institute (CNRRI) (www.cnrri.org).

With strong ties in the international arena
- University of Minnesota (www.mbbnet.umn.edu/res.html)
- University of Florida (www.ufl.edu/research)
- University of California (www.ucop.edu/welcome1.html)
- Cornell University (www.cornell.edu)
- University of Wisconsin (www.wisc.edu)

41. The Royal Soc'y, *supra* note 34.

42. *Id*.

43. *See* IRRI, *Appendix: IRRI's Research Partners* (listing 386 collaborating entities across thirty-four countries), *at* www.irri.org/science/progsum/pdfs/DGReport2004/ PartnerAppendix.pdf (last visited Sept. 15, 2004).

- Iowa State University (www.iastate.edu)
- Other land-grant institutions

National private
- Maharashtra Hybrid Seeds Co. Ltd. (Mahyco) (India's largest private sector seed company) (www.mahyco.com)
- EID Parry Ltd. in Tamil Nadu (www.eidparry.com)
- Rallis India Ltd. (www.tata.com/rallis_india).
- Various hybrid seed companies in China (http://fpeng.peopledaily.com.cn/200101/12/eng20010112_60311.html)
- Seed Co. Ltd. in Zimbabwe (www.samara.co.zw/seedco)
- Kenya Seed Co. and East African Seed Co., Ltd. in Nairobi.

International public
- IRRI (www.irri.org)
- International Maize and Wheat Improvement Center (www.cimmyt.org)
- International Center for Tropical Agriculture (www.ciat.cgiar.org)
- Other international agricultural research centers in the CGIAR (www.cgiar.org) and elsewhere
- John Innes Centre (www.jic.bbsrc.ac.uk)

International private
- Monsanto (www.monsanto.com)
- Syngenta (www.syngenta.com)
- Bayer AG (www.bayer.com/page52.htm)
- Pioneer/Dupont (www.pioneer.com)
- Ceres (www.ceresgroup.com)

As a member of the international public community, IRRI is in a unique position to leverage contributions from both the private and public sectors and to facilitate the sharing of new technologies across all types of institutions. IRRI produces germplasm and knowledge as global public goods.[44] At the same time, it can be an unbiased broker in technology

44. *See* Hei Leung, Gene P. Hettel & Ronald P. Cantrell, *International Rice Research Institute: Roles and Challenges as We Enter the Genomics Era,* 7 TRENDS IN PLANT SCIENCE 139 (2002), *available at* www.irri.org/media/articles/trends.asp.

development and the transfer of proprietary goods between various public institutions—and increasingly between entities in the public and private sectors.[45] IRRI offers a wealth of genetic resources in its genebank, in addition to a collective expertise across biological disciplines that are directly relevant to rice production.[46]

Through its genebank and the International Network for the Genetic Evaluation of Rice (INGER), IRRI invests in research infrastructure to provide germplasm and research support to our NARES partners, such as PhilRice in the Philippines and the Ubon Rice Research Center in Thailand.[47] IRRI's technical expertise makes it a strong partner with advanced research institutions such as the John Innes Centre.[48] The Institute's policy allows it to collaborate widely with numerous institutional partners.[49] Such collaboration brings new technologies to the poor, even as IRRI adheres to its principles and mission.[50] Capitalizing on advances in plant science studies, the Institute provides links between research institutes and rice improvement institutions in the developing world.[51]

IRRI wholeheartedly agrees with Cary Fowler that the continued creation of global public goods is important because the conditions that effectively prevent developing countries from importing proprietary technologies, or producing their own, will persist well into the future. Fowler writes:

> [I]t is important to distinguish between proprietary tools and proprietary products. To the extent that tools—techniques, information, etc.—are proprietary and restricted, developing countries will have a difficult time catching up or applying those tools to develop the necessary products for their citizens. Most developing countries have little capacity to undertake basic research, so access to tools, technologies, etc., is absolutely critical—much more critical in the long run than accessing a protected variety, for instance.[52]

The production of global public goods for our NARES partners is certainly an ongoing role that IRRI and other CGIAR centers can and will want to play.

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45. *Id.* at 140.
46. *Id.*
47. *Id.*
48. *See id.*
49. *See id.*
50. *See id.*
51. *See id.*
52. Fowler, *supra* note 34.

Of course, the Institute stresses the value of developing country access to new technologies through proprietary goods provided by private-sector companies and many public-sector agricultural research institutions, particularly those in the United States. IRRI fully supports this alternative avenue to the public sector's existing supply line for global public goods. Humanitarian brokering of proprietary goods is a role for IRRI and other institutions. It is also a role for PIPRA, the Public Sector Intellectual Property Resource for Agriculture,[53] discussed in a *Science* policy forum article on intellectual property rights last year.[54] For more advanced developing countries, the private sector's actual marketing of its proprietary goods is the more important point of access to cutting-edge agricultural technology. At present, however, questions regarding whether innovating nations will share progress for humanitarian purposes remain.

VI. WILL TECHNOLOGY SUPPLIERS SHARE THEIR PRODUCTS ROYALTY-FREE FOR HUMANITARIAN PURPOSES IN THE DEVELOPING WORLD?

Nobel Peace Prize laureate Norman Borlaug is optimistic that multinational biotechnology companies are willing to devote more of their resources to solving the problems of poor farmers and consumers in the developing world.[55] Creative partnerships are not only being established between private and public research institutions, especially universities, but also with CGIAR centers such as IRRI—with financial support from private companies, governments, and private foundations.[56]

In the end, however, will suppliers of technology—be they private-sector companies or, increasingly, public-sector universities—share their proprietary products royalty-free for humanitarian purposes? IRRI is optimistic that they will. To substantiate such optimism, case studies are in order. The

53. Public Intellectual Resource for Agriculture, *at* http://www.pipra.org (last visited Nov. 11, 2004).

54. Richard C. Atkinson et al., *Public Sector Collaboration for Agricultural IP Management,* 301 SCIENCE 174, 175 (July 11, 2003), *available at* http:// www.sciencemag.org/cgi/reprint/301/5630/174.pdf.

55. Norman E. Borlaug, *International Agricultural Research,* 303 SCIENCE 1137, 1138 (Feb. 20, 2004), *at* http://www.sciencemag.org/cgi/reprint/303/5661/1137.pdf.

56. *See id.*

following two case studies deal with rice: golden rice, a private-sector example, and the *Xa21* gene that confers resistance to rice bacterial blight, a public-sector example.

A. GOLDEN RICE

Golden rice is an example of the value of private-sector donations of intellectual property licenses combined with extensive public sector and charitable research. In 1999, a Swiss-German research team demonstrated that beta-carotene, a precursor to vitamin A, can be produced in the rice grain through the insertion of genes from daffodil and a bacterium.[57] Because rice, consumed by hundreds of millions in developing countries, does not naturally contain vitamin A, this invention has great promise for the Third World.[58] At least 1 million children weakened by vitamin-A deficiency die every year while an additional 350,000 go blind.[59]

Initially, a complex tangle of licenses slowed the development of golden rice.[60] When co-inventors Ingo Potrykus and Peter Beyer started preparing a patent application, they found that potentially seventy different processes or materials used in their work involved intellectual property rights belonging to thirty-two companies and universities in the private and public sectors.[61] The patents ranged from the use of genes in the beta-carotene production pathway to methods for regenerating transgenic plants from transformed cells.[62]

As the inventors struggled with this plethora of patents, Syngenta, the world's largest agricultural biotechnology company, entered the scene.[63] This transnational giant, headquartered in Basel, Switzerland, was created through the merger of the agricultural division of Novartis with Zeneca

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57. *See* Xudong Ye et al., *Engineering the Provitamin A (β-Carotene) Biosynthetic Pathway into (Carotenoid-Free) Rice Endosperm*, 287 SCIENCE 303, 303 (2000).

58. *See id.*

59. J. Madeleine Nash, *Grains of Hope,* TIME, Feb. 12, 2001, at 38, *available at* www.time.com/time/asia/biz/magazine/0,9754,98034,00.html.

60. Roger Beachy, *IP Policies and Serving the Public,* 299 SCIENCE 473 (Jan. 24, 2003), *available at* http://www.sciencemag.org/cgi/reprint/299/5606/473.pdf.

61. *See* Kitta MacPherson, *Getting Out of the Lab and into the World: The Effort to Bring a Genetically Engineered Crop to Developing Countries Takes a Tangled Path,* N. J. STAR LEDGER, Jan. 7, 2002, 2002 WL 3159206.

62. Beachy, *supra* note 60.

63. MacPherson, *supra* note 61.

Agrichemicals in 2000.[64] Syngenta's interest in golden rice, like that of other companies, was not entirely selfless. Rice is extremely important to Syngenta, being one of its strategic crops.[65] Adrian Dubock, in charge of mergers and licensing for Syngenta Seeds, Inc., worked for nearly a year with Dr. Potrykus to contact all the companies with patents underlying the golden rice technology, often appealing to their sense of humanity.[66]

Finally, in 2001, the Rockefeller Foundation, the major financial backer of the original research, announced that five major companies had donated intellectual property licenses: Syngenta Seeds AG; Bayer AG, the German health-care and chemicals company; Monsanto Co., the St. Louis-based agricultural giant; Orynova BV in Japan, a joint venture between Japan Tobacco Co. and Syngenta; and Zeneca Mogen BV, a research subsidiary of Syngenta, based in Leiden, Netherlands.[67] Each company licensed technology used in the research free of charge. In exchange for facilitating the availability of GoldenRice™ for small farmers in developing countries, Syngenta secured rights to the rice for exploitation in developed countries.[68]

These developments had never been achieved before on such a large scale. Although some skeptics believe that most innovations in agricultural biotechnology have been, and always will be, profit-driven rather than need-driven,[69] IRRI believes that Potrykus made a wise decision to involve the private sector in this grand experiment. Potrykus himself says that while obtaining the exemptions was time-consuming, the primary reason golden rice and other bio-fortified crops have not yet begun to help resource-poor farmers and consumers is not patenting, but "regulatory obstacles based on undue paranoia."[70]

The licenses allowed Potrykus and Beyer to deliver the first seed samples of golden rice to IRRI in early 2001.[71] With golden rice developed by Potrykus and Beyer being of the

64. *Id.*
65. *See id.*
66. *See id.*
67. *See id.*
68. *See id.*
69. *See* Conko, *supra* note 13.
70. *Id.*
71. *See* MacPherson, *supra* note 61.

temperate japonica race of cultivated rice, a select team of IRRI scientists has now bioengineered several Asian tropical varieties of the indica rice with genes for beta-carotene biosynthesis.[72] Selected lines, including genotypes of the popular IRRI variety IR64, show expression of beta-carotene, the precursor of vitamin A.[73] Nonantibiotic and marker-free IR64 golden rice is now being evaluated in IRRI greenhouses for agronomic performance.[74] Swapan Datta, golden rice project leader at IRRI, says that meticulous testing for safety and confirmation that humans can indeed absorb this transferred vitamin A in rice is currently under way.[75] Release of indica golden rice to farmers through their local NARES is still four to six years away.[76]

It is a very good sign that so many patent holders granted the golden rice co-inventors their license exemptions. It would be difficult to come up with a more complicated scenario than the golden rice situation. Still, in the end, the project was a success. IRRI is optimistic for the future as scientists at publicly funded, charitable, and corporate research centers begin developing other similar crops, such as new high-protein rice and potato varieties in India.[77] The *Xa21* saga is yet another positive sign.

B. THE *XA21* SAGA

While the golden rice example is particularly relevant to the developing world, the case study of *Xa21* resonates with intellectual property and technology transfer issues affecting international public institutions such as universities in the United States. Roger Beachy states, "[a]s scientific discoveries in biology and biotechnology have led to the development of

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72. *See generally* Karabi Datta et al., *Bioengineered 'Golden' Indica Rice Cultivars with β-Carotene Metabolism in the Endosperm with Hygromycin and Mannose Selection Systems*, 1 PLANT BIOTECHNOLOGY J. 81 (2003), *available at* http://www.blackwell-synergy.com/links/doi/10.1046/j.1467-7652.2003.00015.x/abs/.

73. *See id.* at 82.

74. Ronald P. Cantrell & Gene P. Hettel, New Challenges and Technological Opportunities for Rice-Based Production Systems for Food Security and Poverty Alleviation in Asia and the Pacific, Address at the FAO Conference on Rice in Global Markets and Sustainable Production Systems (Feb. 13, 2004), *in* INT'L YEAR OF RICE 2004, at 11, *at* http://www.fao.org/rice2004/en/pdf/cantrell.pdf (last visited Nov. 16, 2004).

75. *See id.*

76. *See id.*

77. *See* Prakash & Conko, *supra* note 5.

new drugs, crops, and foods, universities have pursued the protection of inventions more aggressively than most... had envisioned in the 1980s."[78] Agricultural technologies pose a particular challenge for university technology transfer programs in balancing commercialization with humanitarian purposes.[79] Although licensing can bring financial benefit to a public institution and its faculty members in times of shrinking budgets and funding shortfalls, it can also damage the public's perception of such institutions as producers of knowledge.[80]

Crop germplasm from developing countries provides a major source of biological material for the development of improved crop varieties and medicines. Biotechnologists are increasingly cloning and patenting genes derived from these sources.[81] One of the most serious bacterial diseases of rice in Africa and Asia is bacterial blight caused by the pathogen *Xanthomonas oryzae* pv. *oryzae (Xoo*). It is one of the oldest recorded rice diseases and has been a problem for more than a century.[82]

The discovery of the protective *Xa21* locus and the eventual patenting of the gene is a saga of the last quarter century that literally spans the globe, from Mali to India to the Philippines and on to New York and California. It involves both international and national public institutions. It also resulted in a unique idea to compensate developing countries for their contributions to agricultural research.[83]

In 1977, scientists at the Central Rice Research Institute in Cuttack, India[84] identified resistance to *Xoo* in an individual plant of the wild species of rice, *Oryza longistaminata.*[85] *Oryza longistaminata* is a weedy perennial that often grows in the vicinity of cultivated rice in many areas of Africa, including Mali, where the individual plant was found.[86] In 1978, IRRI

78. Beachy, *supra* note 60.

79. Atkinson, *supra* note 54.

80. *See* Beachy, *supra* note 60.

81. Pamela C. Ronald, *Genetic Resources Recognition Fund*, 10 AGBIOTECH NEWS AND INFO. 19 (1998), *available at* http://indica.ucdavis.edu/inc/grrfcab.pdf.

82. *Id.*

83. *See id.*

84. Central Rice Research Institute, *at* http://ricecuttackindia.tripod.com (last visited Sept. 7, 2004).

85. *See* Ronald, *supra* note 81.

86. *See* Paul Richards, *Culture and Community Values in the Selection and Maintenance of African Rice, in* VALUING LOCAL KNOWLEDGE:

researchers began breeding studies and later introduced the resistance into cultivated varieties using traditional plant breeding techniques.[87] IRRI found that the resistance was due to a single locus dubbed *Xa21*.[88] In 1990, using material obtained from IRRI, Pamela Ronald, then at Cornell University, mapped the locus.[89] During 1992-95, the University of California at Davis conducted high-resolution mapping, DNA library construction, cloning, and sequencing, which led to the isolation of a few candidate clones carrying *Xa21*.[90] One of these clones conferred transgenic plants with high levels of resistance to bacterial blight.[91] The coding region was located on the transformed piece of DNA, which was also named *Xa21*.[92]

According to Dr. Ronald, once this gene was cloned, there was tremendous international and commercial interest in using it to improve other crops.[93] Species of *Xanthomonas* infect virtually all crop plants.[94] As a result, in addition to improving rice, *Xa21* might be useful in developing disease-resistant wheat, maize, and barley.[95] Dr. Ronald adds that it was likely that, without a patent application on file, there would be less commercial interest and overall investment in developing the gene for use in these other crops.[96]

IRRI recognizes the importance of the equitable sharing of benefits derived from genetic resources obtained from developing countries, but few practical solutions have been devised to achieve this goal. Paul J. Heald at the University of Georgia Law School shares the Institute's frustration. He states that current intellectual property law provides little

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INDIGENOUS PEOPLE AND INTELLECTUAL PROPERTY RIGHTS 209, 211 (Stephen B. Brush & Doreen Stabinsky eds., 1996).

87. *See* Gurdev S. Khush et al., *A New Gene for Resistance to Bacterial Blight from O. longistaminata,* RICE GENETICS NEWSL., 1991, at 121.

88. *See id.*

89. *See* Pamela C. Ronald et al., *Genetic and Physical Analysis of the Rice Bacterial Blight Disease Resistance Locus*, *Xa21*, 236 MOLECULAR AND GENERAL GENETICS 113, 113 (1992).

90. *See* Ronald, *supra* note 81.

91. *See id.*

92. *See* Wen-Yuan Song et al., *A Receptor Kinase-Like Protein Encoded by the Rice Disease Resistance Gene, Xa21*, 270 SCIENCE 1804 (Dec. 15, 1995).

93. Ronald, *supra* note 81.

94. *Id.*

95. *Id.*

96. *Id.*

deterrence to what has been labeled "biopiracy."[97] Yet, perhaps as a step in the right direction in recognizing "long-term occupant communities"[98] as contributors to important scientific advances, U.C. Davis established a voluntary benefit-sharing arrangement it calls the Genetic Resources Recognition Fund.[99] Among the first beneficiaries, the Fund targeted local people in Mali and other developing countries where *Oryza longistaminata* is found.[100] Part of the royalties derived from the licensing of the *Xa21* clone will fund Ph.D. fellowships at U.C. Davis for Malian researchers.[101]

IRRI applauds this initial attempt to reward the contributions of people in developing countries. The February 2004 report of a joint study commissioned by the World Intellectual Property Organization (WIPO) and the United Nations Environment Programme (UNEP) on such benefit-sharing arrangements highlights the need to go beyond simple financial returns and to take account of community needs, capacities and developmental priorities.[102] For example, the report noted that even if there were suitable candidates from Mali for the Ph.D. fellowships, there are no requirements in the existing voluntary arrangements for them to return with their newfound expertise to their local communities.[103] WIPO suggests that the *Xa21* clone and the associated "know-how" should be made available to the Institute of Economic Research in Mali, since the university is currently working with Chinese scientists to transfer the gene into Chinese rice varieties.[104]

IRRI joins WIPO and UNEP in urging developed-world universities and institutions to devise improved voluntary agreements between themselves and developing countries so that the benefits of genetic resources are more appropriately and fairly shared. Even so, the Institute continues to believe that new initiatives such as U.C. Davis's Genetic Resources

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97. Paul J. Heald, *The Rhetoric of Biopiracy*, 11 CARDOZO J. INT'L & COMP. L. 519, 521 (2003), *available at* http://ssrn.com/abstract=285177.

98. *Id.* at 519.

99. *See* Ronald, *supra* note 81.

100. *See id.*

101. *See id.*

102. Press Release, WIPO, Study Takes Critical Look at Benefit Sharing of Genetic Resources and Traditional Knowledge (Feb. 10, 2004), *at* www.wipo.int/edocs/prdocs /en/2004/wipo_pr_2004_373.html (last visited Nov. 16, 2004).

103. *Id.*

104. *See id.*

Recognition Fund, even if in need of additional tweaking, are very positive signs for the future.

One final observation on *Xa21* is in order. Ironically, even though IRRI was a major player in identifying *Xa21* as an important source of bacterial blight resistance, IRRI had to negotiate an agreement with the Regents of the University of California[105] to obtain full rights to develop new rice cultivars using the cloned *Xa21* gene.[106] The agreement allows the Institute to distribute the cultivars and cloned gene to developing countries without restrictions.[107]

If the lines perform well, the agreement grants NARES partners full rights to distribute these lines to farmers in their respective countries. IRRI's partners need not pay any royalties to the University of California.[108] Because rice reproduces true-to-type, the gene is passed onto the progeny and developing-country farmers can grow their own seed for the next season.[109] This exercise was just part of IRRI's role as an unbiased broker in technology development and transfer. It is also another positive sign that suppliers of proprietary goods are willing to provide them for humanitarian purposes.

VII. SUMMARY AND CONCLUSIONS

Technology has been the cornerstone of human progress in the past, and it will remain that cornerstone in the future. Access to new labor-saving, productivity-increasing technologies will play a crucial role in helping the developing world's poor farmers and consumers break out of poverty and obtain food security. Intellectual property rights are here to stay, but these rights are neither the problem nor the solution. The rights themselves are only tools—sometimes powerful and effective, sometimes not so—to use in humanitarian efforts to give developing countries improved access to the new technologies they need, especially GMOs. The key is to match the proper intellectual property rights with specific socioeconomic, technical, commercial, and administrative conditions with particular developing countries, and to manage

105. *See* Ronald, *supra* note 81.
106. *Id.*
107. *Id.*
108. *Id.*
109. *See id.*

them well.

Intellectual property concepts, particularly for crop germplasm, have changed dramatically over the past decade. IRRI and other institutions have worked hard to adjust intellectual property policies in response to the 1993 Convention on Biological Diversity, the International Undertaking on Plant Genetic Resources, and, most recently, the 2004 International Treaty on Plant Genetic Resources for Food and Agriculture. As the Institute looks at different intellectual property regimes and situations in different countries, NARES partners explain that they want specific training on how to deal with issues such as plant variety protection and the movement of germplasm. IRRI places a high priority on this activity and, in conjunction with the International Plant Genetic Resources Institute, is expanding intellectual property training at all institutional levels.

As suppliers of new technologies, the public and private sectors must cooperate to help developing countries obtain both proprietary and global public goods. IRRI has explained its role in facilitating access to both as an unbiased broker for the former, and a continuing producer of the latter. The private-sector must be a major contributing player, and the Institute does not see such contribution as a negative development. Some skeptics believe that the private-sector will not contribute when only humanitarian issues are at stake, but the example of golden rice illustrates that the "Syngentas" of the world truly want to help make a difference and are starting to show admirable goodwill. Moreover, IRRI fully supports attempts, such as U.C. Davis's initiative with *Xa21*, to compensate developing countries for their contributions to the creation of commercial products. Nevertheless, WIPO and UNEP are correct in stating that more must be done.

Although some see an ominous future, IRRI is optimistic. Intellectual property controversies are not insurmountable problems, but rather new and extraordinary opportunities to tap into an exploitable knowledge base. In short, many private companies and public-sector universities are making discoveries that can be channeled by IRRI and others to achieve spectacular gains for the benefit of the poor.