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Information for Research in Developing Countries — Information Technology, a Friend or Foe?

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ABSTRACT

The difference between the advanced and developing countries in the matter of access to information for research has been continually increasing. The advent of the Internet and electronic sources of information has not only exacerbated the gap but also led to the exclusion of developing country researchers from taking part as equal partners in publishing, refereeing, and in international collaboration. If handled imaginatively, the very same technologies can help bridge the information gap between the rich and the poor countries and help improve research productivity worldwide. Many initiatives that are already in place are described and suggestions are given on steps to be taken by developing country researchers.

INTRODUCTION

Research, or dissemination of knowledge, is at once an intensely personal and a social activity. In one's quest for exploring unknown territories one should often feel the loneliness of a long-distance runner — that is the personal aspect. Research is essentially a cerebral activity. But one also needs tremendous experimental skills to succeed. As one may not possess all the needed skills, having collaborators with complementary skills is critical. The aggregation and advancement of knowledge takes place by collective efforts of researchers around the world. In the production of new knowledge, scientists use what is already known. As Newton put it, if we see

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further it is because we stand upon the shoulders of giants. Not only are scientists bright individuals, but they draw upon the literature (or knowledge) generated by others across space and time. That is why we need huge, and expensive, libraries. The generation of knowledge is only one part of the research process; for knowledge to be useful, it should be shared with other researchers and communicated, in a suitable format, to different users/stakeholders. Every scientist also would like his/her work to be used by others. In fact, scientists dream of their papers becoming citation classics. Thus, information and communication are two very important aspects of research. Scientists in developing countries are terribly handicapped in both these aspects.

Doing Science in the Developing World

Even when both information and communication were entirely mediated by the printed word, there was a big gap between the richer and poorer countries that increased with the passage of time. Let us take the example of India. In the 1920s, 1930s, and 1940s, India did rather well in science. It was then that men of the calibre of Srinivasa Ramanujan ("the man who knew infinity", according to the award-winning book by Robert Kanigel), C. V. Raman (India's first Nobel Prize winner in Science), Meghanad Saha (known for his work on thermal ionization), and Jagdish Chandra Bose (who many believe was ahead of Marconi in recognizing the existence of radio waves) performed their world class work. In those days, there were very few journals. But the journals, most of them published in the West, took a few months to arrive in India by sea, and to that extent Indian scientists were behind their Western counterparts in the matter of access to information. In the 1960s and 1970s, there were a large number of research journals, numbering in the range of 50 000, and many libraries in India could subscribe at best only to a few hundred. And although airmail delivery was possible, hardly a few journals came by air, as most libraries could not afford airmail delivery. Some enterprising publishers and vendors offered "air-speeded delivery" which somewhat decreased the time of transit at a relatively low cost. For some reason, interlibrary lending never did catch on India (or in most other parts of the developing world, for that matter). In contrast, in countries like the UK and the USA, where the library facilities are far superior and scientists would not suffer unduly if they did not have access to material from other institutions, hundreds of thousands of interlibrary loan transactions take place every year. The net result was that scientists in developing

countries suffered a great deal of relative disadvantage compared to their Western counterparts.

Today many institutions in developing countries cannot afford to maintain good libraries. Most libraries in sub-Saharan Africa have not subscribed to any journal for years. Seun Ogunseitan, the Nigerian journalist-turned-information provider, asks that if scientists in many African universities often have to rely on what they are told by newspapers, by friends, or by *Time* magazine, how can they ever compete with scientists in the USA and Western Europe when there is such a vast difference in their ability to access information, either through print media or electronically? Indian Institute of Science, Bangalore, the best-funded library among all Indian institutions of higher education, has an annual library budget of approximately Rs 90 million (about $1·8 million). Only a handful of Indian libraries have a budget of around Rs 10 million (about $200,000). Of course, there is no comparison with the acquisition budgets of even modest university libraries in the United States. Even in the West, universities and research institutions are facing a major "serials crisis". The cost of journals is escalating at a rate much higher than the general inflation rate. According to the Association of Research Libraries, the median subscription cost of a journal rose from $87 in 1986 to $267 in 1999 at an alarming 9% annual growth rate. In 1986, research libraries in North America purchased an average of 16 312 serial titles and 32 679 monographic titles. By 1999, research libraries purchased 15 259 serial titles, or 1053 fewer, and 24 294 monographic titles, or 8385 fewer.[1] No wonder institutions in developing countries are unable to subscribe to even a small number of core journals. A large part of price escalation comes from commercial publishers of science and technology journals. The last few years have witnessed the emergence of many initiatives to meet the "serials crisis" and some of them are eminently advantageous to scientists and scholars in the developing world. We will look at them shortly.

Technology Divides

If escalating costs of print journals have made life miserable for scientists (and other scholars) in developing countries, the advent of electronic sources of information has made the situation even worse. It is in the nature of any new technology to exacerbate the existing divide between the rich and the poor. The newer and more potent the technology, the greater its ability to increase inequalities. The rapid changes taking place in the ways

[1]Trends in ARL libraries: Introduction to ARL Statistics 1998–99. 〈http://www.arl.org/stats/arlstat/99intro.html〉.

new information is published, stored, disseminated, and retrieved using the rapidly advancing information and communication technologies (ICTs) have exacerbated the relative deprivation suffered by researchers in the developing world. The new ICTs have not just made each operation faster, but cause greater synergy between these operations in ways unthinkable in the print era.

Let me give an example. If your library subscribes to *The Web of Knowledge* as well as electronic versions of journals published by several leading publishers (such as Reed Elsevier, Academic Press, Wiley InterScience, and Wolters Kluwer) with whom ISI has agreements, you can, sitting in front of your terminal, seamlessly move from one paper in a journal published by Elsevier to the full text of another paper (which is cited in the first paper) in a journal published by another publisher. All within a few seconds with a few keystrokes or mouse clicks. Even if your library does not subscribe to the *Web of Knowledge*, one can move from one paper to another through CrossRef, a not-for-profit network based on publisher collaboration. To move from one paper to the other, if you were unfortunate enough to work in a developing country, you will have to note down the reference, leave the first journal, move into the stacks and search for the specific volume of the second journal and open the right page. Often, there may be no institutional subscription to the second journal, in which case, you either look up an abstracting service, if it is available in your library, and be satisfied with an abstract, or ask for a reprint from the author, if you can find his/her address. He or she may normally reply giving you a URL where you may have to pay for viewing the article. Usually, this process may take from several days to a few weeks, and psychologists maintain that one loses interest if one does not get what one wants within a reasonable time. The relative disadvantage suffered by scientists from developing countries during the 1920s, 1930s, and 1940s is nothing compared to the frustrating situation of 2002.

When many journals started publishing electronic versions they started accepting manuscripts electronically and got the papers reviewed electronically. Many scientists in developing countries, who did not have access to personal computers, email, and the Internet, could neither submit their papers to these journals nor read them or act as referees. They became "excluded". The irony is that some highly qualified scholars do not referee *merely* because they are *technology deprived*!

Let me give one more example to illustrate how lack of access to the right kind of technology can jeopardize one's chances for participation in research programmes. The decline of global political blocks, expansion of convenient and not-so-expensive air travel, and above all the advent of the Internet have facilitated scientific communication, contact, and collaboration. More research and development collaborations are likely to

develop with Internet-facilitated innovations such as virtual research laboratories and the simultaneous use of distributed virtual data banks by researchers around the globe, and "grids", which depend in a fundamental way on access to high bandwidth networks. In the West, such networks have become both affordable and highly reliable. Most researchers in developing countries, even those who are eminently qualified to take part in such collaboration, are excluded simply because they do not have access to the right technology.

Thus the new ICTs, left to their own devices, will surely widen the knowledge divide or the disparities in people's capacities to do research and their ability to use them to their advantage. Thanks to men like Gandhi, Martin Luther King, Nelson Mandela and Desmond Tutu, we have abolished skin-colour-based apartheid, but are allowing the new ICTs to create information-access-based apartheid.

Lack of Visibility

Inadequate access to literature or information is not the only problem faced by scientists in developing countries. An equally important problem is that research conducted in developing countries lacks visibility. Nobody notices it. Nobody quotes it. It gets buried in an obscure corner of the world output of literature. The same is true for most journals published in developing countries. Very few papers published from developing countries become citation classics or find a place in the list of key papers on the emerging research front. Toni Morrison, the first Black woman to win a Noble Prize for Literature, once said that writing about the life and sensibilities of Blacks did not count. It was not considered important. It was peripheral. It is the same with doing science in developing countries. After years of doing research under rather difficult conditions, one still finds oneself in the category of also-rans.

The Gap is Widening

Clearly, the advent and rapid development of the new ICTs have not really helped scientific research in the developing countries. The Internet access gap between the rich and the poor areas of the world is not only large, but is also growing, says the *Science and Engineering Indicators* 2002. In 1997, Internet host penetration rates in North America were 267 times greater than rates in Africa;[2] by October 2000, the gap had grown to a multiple of 540.

[2]National Science Board (2002) Science and engineering indicators—2002. Arlington, VA: National Science Foundation.

History has shown us that any technology will exacerbate the existing divides. And ICTs have exacerbated the existing inequalities in the world of science in such a short time. But, in my opinion, one does not have to lose hope. As demonstrated by the award-winning Information Village project of the M. S. Swaminathan Research Foundation in India, if intelligently and innovatively used, the very same ICTs can become an ally in our efforts at bridging the divides,[3] even in the world of science and research. We now examine this point further.

Efforts Afoot

The past few years have witnessed several developments that could make access to information for scientists in the developing world a lot more affordable. These include initiatives promoted by scientists, libraries, publishers, academies, and societies. A few of them are described here.

Public Library of Science (PLoS) ⟨http://www.publiclibraryofscience.org⟩
The PLoS, a grassroots initiative by scientists, is a non-profit organization of scientists committed to making the world's scientific and medical literature freely accessible to scientists and to the public around the world, for the benefit of scientific progress, education, and the public good.

The aim is to establish international online public libraries of science that will archive and distribute the complete contents of published scientific articles, and foster the development of new ways to search, interlink, and integrate the information that is currently partitioned into millions of separate reports and segregated into thousands of different journals, each with its own restrictions on access.

As a step toward these goals, scientists around the world have been circulating an open letter urging publishers to allow the research reports that have appeared in their journals to be distributed freely by independent, online public libraries of science. More than 30 000 people from 177 countries have signed the open letter, as of 15 June, 2002. This initiative has prompted some significant and welcome steps by many scientific publishers towards freer access to published research, but in general these steps have fallen short of expectations of the proponents of this idea.

Scientists everywhere, and especially in developing countries, should make every effort to publish their work in, and give their full support to, those journals that have adopted the policy proposed in the open letter.

[3]Arunachalam S. (2002) Reaching the unreached: How can we use ICTs to empower the rural poor in the developing world through enhanced access to relevant information? Paper presented at the IFLA General Conference, Glasgow, 18–24 August 2002.

The PLoS plans to launch online journals that will publish original research papers, timely reviews, essays, and commentary online. Unrestricted rights to access, distribution, and use of all articles published by PLoS will be assigned to the public domain, subject solely to the condition that the original authors of each work be properly credited in any complete or partial copy or derivative work. The journals will have rigorous peer review and high editorial standards. The costs of peer review, editorial oversight, and publication will be recovered primarily by charges to authors, which are expected to be approximately $300 per published article. Costs will be subsidized for authors from developing countries who cannot afford these charges.

International Scholarly Communications Alliance (ISCA) 〈http://www.curl.ac.uk/about/isca.html〉

A new international scholarly communications alliance formed by eight of the world's principal research library organizations in February 2002 will broaden access to research and facilitate transformation of knowledge dissemination. ISCA members — about 600 research libraries worldwide — are working together to support equitable access to scholarly literature and to take united action to create appropriate policies. The alliance will concentrate on ways to ensure open and affordable access to scholarship across national boundaries. ISCA is an action-oriented global network that will collaborate with scholars and publishers to establish equitable access to scholarly and research publications.

ISCA will engage in a series of activities that focus the scholarly publishing process on the primary goals of the academic research community, advancing the discovery of new knowledge and facilitating its dissemination. Through sharing expertise on scholarly communications issues, these organizations, whose total library budgets equal over US$5 billion and which serve well over 11 million students and faculty, will be prepared to act as a unified body in creating policies and taking actions that advance these goals. *Larger libraries in developing countries will do well to coordinate their policies with ISCA.*

As a body, ISCA will promote solutions which its members agree are necessary, practical, and viable approaches. Current advocacy programs include:

- Scholarly Publishing and Academic Resources Coalition (SPARC), http://www.sparc.org, the ARL-initiated effort to facilitate competition in scientific communication through the creation of high-quality, low-cost alternatives to expensive commercial titles, and SPARC Europe, recently launched to provide a European operational arm for SPARC activities.

- The establishment of institutional and discipline-based archives that allow public access to content and employ the Open Archives Metadata Harvesting Protocol.

SPARC

SPARC emerged from the widespread perception that in scientific comunication the researchers and the laboratories — where scientific communication originates — had been forgotten or sidelined and the profit motive of commercial publishers had taken over. SPARC's avowed aim is to restore the role of the researcher in research publishing. SPARC persuades editors and editorial board members of unduly expensive commercial journals to start new journals of high quality. SPARC journals have become popular within a few years of their first publication. The ACS journal *Organic Letters* has already registered a higher impact factor than its main commercial rival *Tetrahedron Letters*. *Theory and Practice of Logic Programming*, published by Cambridge University Press, came into being as the entire 50-member editorial board of *Journal of Logic Programming* resigned to protest against the unreasonable increase in subscription fees and subsequently launched the new journal. The new journal is doing much better than its costlier rival. Another SPARC partner journal, *Evolutionary Ecology Research*, was founded by the former editor and editorial board members of *Evolutionary Ecology*, the price of which was increasing at the rate of 19% per year over a 12-year period. The new journal costs much less for the subscriber and is doing much better than its commercial rival.

Scientists from developing countries should submit their work to SPARC journals rather than to the expensive journals they are trying to replace.

Open Archives Initiative (OAI) 〈 http://www.openarchives.org 〉

The OAI develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. The OAI has its roots in an effort to enhance access to e-print archives as a means of increasing the availability of scholarly communication. Continued support of this work remains a cornerstone of the Open Archives program. The fundamental technological framework and standards that are developing to support this work are, however, independent of both the type of content offered and the economic mechanisms surrounding that content, and promise to have much broader relevance in opening up access to a range of digital materials. The OAI is supported by the Digital Library Federation, Coalition for Networked Information, and the National Science Foundation.

The full-text physics archive, **arXive**, founded by Paul Ginsparg at Los Alomas in 1991, is probably the oldest and the most prominent subject-specific e-print server. With more than 15 mirror sites around the world, including five in Asia (India, China, Japan, South Korea and Taiwan), one in

Brazil, and one in South Africa, this automated electronic archive covers research papers in physics, mathematics, non-linear sciences, computational linguistics, and neuroscience. The arXiv database contains about 140 000 free full-text research papers, of which about half are in astrophysics and high-energy physics. This pioneering effort is easily one of the most innovative and successful experiments to date in scholarly communication. Another physics database is the **SPIRES HEP** literature database, where one can search more than 450 000 high-energy physics-related articles, including journal papers, preprints, e-prints, technical reports, conference papers and theses, comprehensively indexed by the SLAC and DESY libraries since 1974. **The Digital Library for Physics, Astrophysics, and Instrumentation** [http://adswww.harvard.edu], hosted by the Harvard-Smithsonian Centre for Astrophysics and funded by NASA, maintains four bibliographic databases containing more than $2 \cdot 6$ million records. **ResearchIndex** (or **CiteSeer**), the full-text archives for computer science, founded by Steve Lawrence of NEC Research, Princeton, NJ, is a scientific literature digital library that aims to improve the dissemination and feedback of scientific literature, and to provide improvements in functionality, usability, availability, cost, comprehensiveness, efficiency, and timeliness. ResearchIndex uses search engines and crawling to efficiently locate papers on the web. Authors need not submit their papers in any special format. It is the largest e-print archive with more than 400 000 papers. The full source code of *ResearchIndex* is available at no cost for non-commercial use. **Cogprints**, the archive for cognitive sciences founded by Steve Harnad at Southampton University, United Kingdom, is an electronic archive for papers in any area of psychology, neuroscience, and linguistics, and many areas of computer science, philosophy, biology, medicine, and anthropology, as well as in other fields pertinent to the study of cognition. **Clinmed** [clinmed.netprints.org], launched in December 1999 as a collaborative venture of the BMJ Publishing Group and Stanford University Libraries' HighWire Press, is a website that provides a place for authors to archive their completed original research into clinical medicine and health — before, during, or after peer review by other agencies. There are similar services in economics (RePEc) and computing (CoRR).

Electronic e-prints do not aim merely to capture the articles; it is far more than a simple electronic reproduction of what would appear in print journals. E-print publication on the web offers numerous value-added elements, such as multi-media and data sets, as well as contextual links to other documents referred to in a paper, and to databases. Indeed, the document linking advantage is being exploited by digital libraries, commercial aggregators of journals, and secondary service providers such as ISI and Chemical Abstracts Service. In the very near future, the print versions of

journals will not be the true archivers. The e-print archives, as both the data and the access systems can be mirrored in several locations around the world, offer built-in insurance against possible loss of archived material due to unforeseen calamities (such as natural disasters or system failures at any one location). For some reason, e-print archives in fields other than physics and computer science are not growing fast enough despite some well-meaning efforts. A commercial publisher has established ChemWeb, a preprint server for chemistry, but it is not yet as popular as the physics preprint servers. By the end of July 2002, it could boast only 500 preprints. The reason is that disciplines are not the right agent for change, says Prof. Steve Harnad of the University of Southampton. "The right entity for all of this is the university", says Harnad, an outspoken proponent of open access to scientific literature. According to him, universities have an economic incentive to try to reduce the cost of scientific publishing. A number of leading American universities are creating and maintaining institutional archives. These include the Dspace initiative of MIT, the OSU Knowledge Bank of Ohio State University, the Scholarship Repository of the University of California system, and Caltech's institutional repository.

Developing country scientists should use the existing archives to disseminate their work as well as to learn about the work of others. They may also establish institutional archives and national level e-pint servers, especially in fields such as agriculture and health sciences. The Indian Institute of Science, Bangalore, has just initiated an institutional e-prints archive.

PubMedCentral ⟨ http://www.pubmedcentral.gov ⟩

PubMed Central is a digital archive of life sciences journal literature, developed and managed by the National Center for Biotechnology Information (NCBI) at the United States National Library of Medicine (NLM). With PubMed Central, NCBI is taking the lead in preserving and maintaining open access to the electronic literature, just as NLM has done for decades with the printed biomedical literature. PubMed Central aims to fill the role of a world class library in the digital age. It is not, and has no intention of becoming, a journal publisher. Access to PubMed Central is free and unrestricted.

PubMed Central follows in the footsteps of other highly successful and useful services that NCBI has developed for the worldwide scientific community: GenBank, the genetic sequence data repository, and PubMed, the database of citations and abstracts to biomedical and other life science journal literature. GenBank, and the tools provided by NCBI for searching and manipulating its contents, have been a boon to molecular biologists and have helped advance developments in the field. PubMed (which encompasses Medline) is a good database for researchers and clinicians alike, to

locate relevant articles and, in many cases, to directly link to a publisher's site for the full text.

The value of PubMed Central, in addition to its role as an archive, lies in what can be done when data from diverse sources is stored in a common format in a single repository. GenBank has proven the advantages of collecting DNA sequences in a central repository with a common format. You get more rapid searching, manipulation, and cross-linking of the complete collection, and all the benefits that derive from that. Similarly, with a well-populated PubMed Central archive, one will be able to quickly search the entire body of full-text literature and locate relevant material regardless of its source. It also becomes economical and practical to develop tools to integrate the literature with a variety of other information resources such as sequence databases and other factual databases that are available to scientists, clinicians, and everyone else interested in the life sciences. The intentional and serendipitous discoveries that such links might foster excite us and stimulate us to redouble our research efforts.

Many journals already have online publishing operations and there is a growing tendency to publish material online only, to the exclusion of print. This literature must be preserved in a form that ensures open access to it over the longer term. This is what NCBI has undertaken to do. *Scientists from developing countries should encourage all journals to join such efforts.*

Journals

There are a number of journals and archives which are now available free on the web. The most prominent among the journals is the *British Medical Journal* (BMJ), one of the earliest to be made available free. Indeed, the electronic version of *BMJ* carries additional material that could not be accommodated in the print version for want of space. **BioMedCentral** [http://www.biomedcentral.com] publishes more than 50 journals, provides free access to all papers, and encourages new free journals. It charges a handling charge of $500/article from the authors or their institutions (except those from the developing world and some other authors for whom the charge is waived). Full texts of more than 750 medical journals are available free on the web, and the number is increasing [http://www.freemedicaljournals.com]. The Association of Research Libraries, USA, has published a *Directory of Electronic Journals*, which lists several hundred titles that provide free access.

The Open Society Institute (Soros Foundation) [http://www.soros.org/openaccess], founded by the financier George Soros, has issued a statement advocating open access and has provided $3 million over 3 years for projects supporting "alternative" journals and open archiving initiatives.

The African Virtual University is a "university without walls" that uses modern ICTs to give institutions in sub-Saharan Africa direct access to

some high-quality learning resources. It provides students and professionals in 17 countries free email accounts and access to an online digital library with over 1000 full-text journals.

Non-profit initiatives

There are a few non-profit publishers/distributors of developing country journals and information. These include Bioline International [http://www.bioline.org.br], which hosts electronic versions of many developing country journals (most of them at a modest subscription fee); International Network for the Availability of Scientific Publications, or INASP [http://www.inasp.info/index.html], a co-operative network of partners whose mission is to enhance the flow of information within and between countries, especially those with less-developed systems of publication and dissemination; SciELO [http://www.scielo.org], which hosts more than 80 journals published in Iberian and Latin American countries, such as Brazil, Chile, Costa Rica, Cuba, and Spain; and African Journals Online or AJOL [http://www.inasp.info/ajol/index.html], that provides free online access to titles and abstracts of more than 60 African journals and full texts on request.

Health Internet (HINARI) [http://www.healthinternetwork.org], a UN/WHO initiative, aims to provide commercial medical journals free to licensed countries in the developing world. The Programme for the Enhancement of Research Information (PERI) [http://www.inasp.info/peri/index.html], promoted by INASP, supports information production, access and dissemination for research partners in developing and transitional countries utilizing ICTs.

The Electronic Publishing Trust for Development (EPT), established in 1996, facilitates open access to the world's scholarly literature and the electronic publication of bioscience journals from countries experiencing difficulties with traditional publication. The main activities of the EPT are to provide awareness of the benefits of electronic publishing, transfer e-publishing technology through training and online resources, provide management and distribution support, and support open access initiatives and make them known to scientists and publishers from developing countries.

What Needs to be Done?

What we want to achieve is to make scientific and technical information flow freely and be accessible at affordable costs to researchers and students everywhere in the world; a kind of enlightened socialism, as it were, for scientific knowledge. To be honest, this could only be an ideal — the direction in which we should move. Achieving this goal would necessarily mean

exploring many possibilities. First, we should try to facilitate access to all the content (scientific and technical journal papers, reports, theses, conference papers, bibliographic, factual, and full-text information, etc.); second, we should ensure all potential users of this content have access to the technological tools to access it (such as high bandwidth Internet connections); third, we should continue with our efforts to evolve standards and norms, including research, into better ways of doing things that will enhance the ease of use and value of the content; fourth, we should build organizational structures that would ensure the long-term survival of the entire system.

As we saw in the previous section, there have been many efforts to enhance free and low-cost access to content of different kinds. A number of journals are available for free access a few months — ranging from 6 to 24 months — after publication. Many high-impact journals are given such delayed access by High Wire Press of Stanford University. Parts of certain journals such as *The Economist* and *The New Scientist* are available free on the web.

Scientists in developing countries and organizations that care for their welfare such as the Third World Academy of Sciences and the Inter Aacdemy Panel should bring pressure on publishers to make electronic access to their journals free or at least make them freely available a few months after publication. They should support the Public Library of Science movement.

Unfortunately, established publishers would not like to lose their stranglehold on the scholarly journals market and will try to scuttle the open source movement. For example Ingenta, a leading for-profit aggregator of electronic journals, persuaded half a dozen champions of the open source movement to be on their advisory board!

A few months ago, the Director General of the World Health Organization (WHO), Dr Gro Harlem Brundtland, and the editor of *BMJ*, Dr Richard Smith, negotiated a deal with leading publishers of biomedical journals, to make their journals freely accessible to public institutions, universities, and hospitals in more than a hundred developing countries. The main criterion for selection of countries was per capita GDP of less than $1000. But the publishers did not extend the benefit to several countries that met this criterion (e.g., India, Pakistan, and Bangladesh), on the grounds that they already have many subscribers in those countries and they would lose business! In essence, they are willing to give free access to their journals to countries where there are hardly any users. A clear case of having the cake and eating it too. WHO should renogotiate the terms and enable all developing countries to gain free access to these journals.

Organizations such as FAO and ISNAR may take the lead for working out a similar arrangement for institutions in developing countries to gain free access to agricultural (and related) journals. The Inter Academy

Panel, formed by over 80 Science Academies worldwide, can lend its support to such a move.

It is not just the commercial publishers who are making it difficult for developing country scientists to gain free access to information. Even some society publishers are unwilling to provide free, open access to their journals, largely because subscriptions to their journals are their major source of income. What is more, recently *Science*, the weekly journal of the AAAS, published the draft rice genome sequence (of the *japonica* strain of rice) by scientists from the Swiss agrochemical company Syngenta, without requiring the company to deposit its data in a public database such as GenBank! "Foul" cried many scientists, but AAAS could not care less. In the same issue, a Chinese-led team of academics had published a blueprint of the *indica* strain of rice, and the map is available in GenBank. This is not the first time *Science* has allowed private interests to trump the public good. Earlier, it allowed Celera to withhold data on the human genome sequence. Scientists everywhere, and especially those in the developing world, should persuade *Science* and AAAS (and other organizations) not to sacrifice the commonweal on the altar of commercial interests.

The National Academy of Sciences (NAS), USA, is a model for other societies and academies. Not only the Academy's *Proceedings* but also its entire collection of over 2000 reports are available free on the web to users in developing countries. Indeed, Professor Bruce Alberts, the President of NAS, is a great champion of the cause of science and technology in developing countries. He played an important role in founding the Inter Academy Panel and the Inter Academy Council. Alberts suggests the following two-part strategy:[4]

i. Connecting all scientists to the World Wide Web, where necessary, by providing subsidized Internet access through commercial satellite networks; and
ii. Taking responsibility for generating a rich array of scientifically validated knowledge resources, made available free on the web, in preparation for a time when universal Internet access for scientists will be achieved in both developing and industrialized nations.

Both of these are excellent suggestions. Not only do we need useful content to be available free on the web, but we also need the technology in place to take advantage of the content. *A concerted effort should be mounted to persuade philanthropic foundations and donor agencies concerned with higher education and research to donate funds to make available PCs and high-bandwidth Internet connections to researchers and libraries in developing countries.* The concerned governments

[4]Alberts B. (1999) Science and the World's Future, President's Address to the Fellows of the National Academy of Sciences, USA, Washington D.C., 136th Annual Meeting, 26 April 1999.

should make things easy for the spread of ICTs among university and research institutions. Again, this is easier said than done. Let us take the case of India. The famous Delhi University does not yet have a campus-wide network. There was talk about a nationwide academic network called Sankhya Vahini to be established in collaboration with a few Indian-born professors at Carnegie-Mellon University. After nearly 3 years of raising hopes, the project was abandoned. Now the talk is about Vidya Vahini and no one is sure when it will materialize.

There is a great need for building awareness among Third World researchers and research managers about electronic journals, open archives, benefits of networking, etc. A few months ago the Indian Academy of Sciences held two workshops on electronic publishing with help from the Electronic Publishing Trust, IDRC, and INASP. Open access evangelists like Steve Harnad should be taken around important centres of research in the Third World and asked to address scientists and scholars. A reader on the advantages of going electronic and current developments must be produced and circulated widely. Librarians in the Third World should be given special training to play their role of information intermediaries in the changed circumstances. In short, the transition from print-based access to electronic information access in the Third World should be facilitated by lectures, workshops, training programmes, and hands-on experience.

While agencies such as EPT and INASP can help with the training programmes, organizations such as IAP, IAC, and NAS can persuade the scientific communities and the governments in the Third World to overcome any inertia or barriers to making the transition. Donor agencies such as IDRC and the Soros Foundation can provide the necessary investments to make the transition happen soon. Then, access to information for research will truly become democratic and the divide between the rich and the poor will be considerably reduced.