

Nanotechnology and the Global Poor: United States Policy and International Collaborations

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ABSTRACT

Nanotechnology and nanomanufacturing have tremendous potential for benefiting the global poor—the approximately 2.77 billion people in the world that live on less than 2 dollars per day (purchasing power parity). For example, nanotechnologies may help provide reliable local energy production and potable water availability, increased agricultural efficiency, inexpensive medical diagnostics and treatments, and greater access to technology and information more generally [1]. This paper examines existing and potential pathways for promoting nanotechnology and nanomanufacturing that benefit the global poor either by directly meeting their needs or supporting nascent industries in developing countries. Informal international collaborations as well as formal international research partnerships are discussed, as is the role of international organizations. However, special attention is given to U.S. policy. Recommendations regarding intellectual property licensing, incentivizing research on pro-poor nanotechnologies, and promoting collaborations between U.S. and developing world researchers are made. In the long run, a nanotechnology research and development strategy conducive to realizing the possibilities for nanotechnology to benefit the global poor might constitute an effective form of foreign aid that would also benefit the U.S. by promoting stability and security in developing nations and creating new markets for U.S. companies.

Keywords: global poor, United States, international collaborations, foreign aid, nanotechnology

1 BARRIERS TO NANOTECHNOLOGY IN THE DEVELOPING WORLD

Perhaps the most basic barrier to conducting nanotechnology research is equipment costs. One way for a researcher in a developing nation to reduce these costs is by collaborating with other researchers, either from another developing nation (South-South collaboration) or from a developed nation (North-South collaboration). Each type of

partnership has benefits and limitations. While South-South research is more likely to focus on developing world problems, resources may still be constrained; and while North-South collaboration enables access to high-tech facilities, little incentive exists for developed world researchers to partake in such collaborations.

The lack of incentives for researchers in the developed world to aid the developing world is a critical barrier to diffusing nanotechnology. There is little or no financial incentive for developed world researchers to make the required effort to work with developing world researchers. Similarly, there are very few funding sources that exist to provide incentives for developed world researchers to independently address the social problems facing the developing world (pro-poor research).

Relevant to the issue of incentives is patents. Patents are being aggressively sought with respect to all aspects of nanotechnology research, including equipment to conduct research. Such layered patenting drives costs prohibitively high for developing world researchers [2]. As with pharmaceuticals, the exclusive rights associated with patents also are likely to be a major barrier to bringing nanotechnology to the developing world.

Among the non-technical barriers to nanotechnology research and applications in the developing world are bad governance, anti-science attitudes, lack of health care, and lack of resources in all levels of education. In cases where these problems are severe, applying pro-poor technologies (as part of broader development strategies) will probably be more feasible than attempting to build scientific capacity.

An additional, substantial non-technical barrier is the political realities of foreign aid. There is often conflict over how and where foreign aid should be spent, and in the past aid to develop scientific capacity has been criticized when more fundamental needs go unmet [3]. Moreover, nanotechnology remains unproven and the risks associated with nanomaterials largely unknown, which is particularly problematic for developing nations with meager regulatory capacities. Furthermore, the U.S. is a global competitor in nanotechnology, so there is a focus within U.S. nanotechnology policy on assuring status as a global leader, rather than helping others.

2 PATHWAYS FOR NANOTECHNOLOGY

A United Nations Millennium Project report suggested that, "Nanotechnology is likely to be particularly important in the developing world, because it involves little labor, land, or maintenance; it is highly productive and inexpensive; and it requires only modest amounts of materials and energy." [4]

Nanotechnology is already a global phenomenon. Developing and poorer countries are contributing to worldwide nanotechnology research, and some are even moving toward commercialization in certain areas. Many developing nations, particularly Brazil, Mexico, Argentina, and South Africa, have official nanotechnology research initiatives. Some poorer nations, such as Nigeria and Colombia have seen individuals contribute research on nanotechnology. Countries of all economic levels all over the world are participating in nanotechnology research.

2.1 Nanotechnology Research in the Developing World

The South African Nanotechnology Strategy (SANS) is an example of developing world nanotechnology research that engages both the social and industrial potential for nanotechnology [5]. South Africa's pro-poor research seeks to not only apply nanotechnology towards the problems of poor South Africans, but also to the greater problems faced across all of southern Africa. Technical projects SANS currently works on include those involving nano-membranes for delivering clean water, improved solar cells, and the development of fuel cells. For example, South Africa funded a pilot nanofiltration water treatment plant which proved to be a successful and sound alternative for water filtration in rural South Africa [6].

South Africa's industrial research seeks to apply nanotechnology in areas such as nanocomposites, nanomaterials, and other areas that can enhance Africa's resource-based industries. South Africa already has a commercialized nanotechnology innovation in the area of nanocatalysis, which it hopes to use to add value and productivity to its active mining industry. By focusing industrial nanotechnology research on domestic industries, South Africa will be able to add value and productivity to its industries, both nascent and already established, and export technologies abroad. This approach can serve as a model for other developing nations.

In South America, Argentina and Brazil have created a partnership known as the Argentinean-Brazilian Nanotechnology Center, which focuses on industrial and social applications of nanotechnology, as well as pro-poor technologies. Brazil, similar to SANS, is applying industrial nanotechnology research to one of the nation's major industries, agriculture. Brazil's agricultural research organization, EMBRAPA, has already developed a "food-

taste" sensor capable of rapidly detecting various parameters of locally grown agricultural products.

2.2 Partnerships and Collaborations

SANS and the Argentinean-Brazilian Center constitute formal South-South partnerships, since they have a regional emphasis and a desire to work with other developing nations. Although these exist, along with more informal South-South collaborations, it is more common to find North-South partnerships and collaborations.

Although informal North-South collaborations exist, as discussed above, there are few incentives to promote them. Moreover, it is difficult to track and quantify informal collaborations, which in turn makes it difficult to assess their robustness or effectiveness. Here the focus is on more formalized North-South partnerships.

In 2005, Argentina, in addition to developing its own nano research labs, established a partnership with Lucent Technologies and its Bell Labs facility in New Jersey. When Argentinean scientists need to conduct research with equipment more sophisticated than is currently available in-country, they can work with Bell Labs researchers and facilities. This partnership gives Argentineans access to more advanced technology, reducing equipment costs, and gives Lucent Technologies access to new talent and marketable research, thus providing incentive for the partnership. Also, as with South Africa, Argentina's nanotechnology research focuses on a preexisting domestic industry, semiconductor fabrication.

Academic institutions in Mexico have partnered with the University of Texas at Austin (UT) to form the International Center for Nanotechnology and Advanced Materials (ICNAM) [7]. Again, this partnership provides Mexican researchers access to more advanced equipment and provides UT with exposure to new talent. Also, Albany Nanotech and the University of Albany College of Nanoscale Science and Engineering have forged a formal partnership with the Centro de Investigación en Materiales Avanzados (CIMAV) in Mexico. Both sides in this partnership are capable of advanced nanotechnology research, so the goals are to leverage the resources of each institution and provide opportunities for researchers to expand their knowledge through international collaboration.

The European Union has encouraged North-South collaborations through its Framework Programmes (FP). Under FP, a developing nation can receive research funding if it applies in collaboration with an EU nation. South African researchers have already collaborated with EU researchers under FP on nanotechnology research [8]. Another product of FP is NanoforumEULA, which funds exchange visits for 20 Latin American researchers at research organizations in the EU each year [9]. The goal is to create lasting relationships and provide developing world researchers with access to high-tech nanotechnology facilities.

3 U.S. FOREIGN AID POLICY

The U.S. currently spends more than any other nation on foreign aid in real terms, yet it spends among the least as a percentage of gross national income (GNI) when compared to other major donor governments [10]. Currently, there is no national effort to bring nanotechnology to the developing world, but there are many potential avenues to do so.

3.1 Potential Pathways

The Bill and Melinda Gates Foundation, which funds pro-poor research, provides a model the U.S. could follow. Fabio Salamanca-Buentello and Peter Singer have suggested creating a similar international fund to support development-focused nanotechnology research [11]. The U.S. could attempt to achieve this through multilateral organizations such as the U.N., or it could set up its own fund through nanotechnology grant providers such as the National Science Foundation (NSF) and the National Institutes of Health (NIH). This approach is not likely to build research or industrial capacity in developing nations, but might be effective in promoting development of pro-poor technologies.

Although the developing world would benefit from funds for pro-poor research, it would benefit more from assistance that helps to build research, industrial, or economic capacity domestically. The U.S. could offer funding for North-South collaborations related to nanotechnology and development in several ways. The NIH and NSF could make such collaborations a criterion for certain types of grants. Also, the Department of State's Science, Technology, and Engineering Mentorship Initiative, which currently seeks to enhance Iraq's scientific capacity by forming relationships between Iraqi and U.S. scientists, could be expanded to other developing nations.

The U.S. could also use multilateral avenues, such as the U.N. or the World Bank to build scientific capacity in developing nations. The U.N. has established international shared-use research facilities, and the Third World Academy of Sciences (TWAS) has proposed creating a shared-use nanotechnology research lab in sub-Saharan Africa [12]. Additionally, the U.N. and TWAS have established South-South researcher exchanges which allow knowledge expansion without encouraging a 'brain-drain' from developing nations [13]. The U.S. could encourage and fund the expansion of these multilateral routes to promote nanotechnology in developing nations.

However, the greatest potential for a broad initiative rests with the main foreign aid organizations, the U.S. Agency for International Development (USAID) and the Millennium Challenge Corporation (MCC), which have experience funding development related research. Although USAID currently lacks any programs linking

nanotechnology and development, its efforts to bring biotechnology to developing nations serve as a promising framework for nanotechnology. USAID has funded partnerships between U.S. research organizations and developing world scientists to tackle specific agricultural issues. For example, with USAID funding, researchers at Purdue University have worked closely with African scientists to develop a strain of sorghum resistant to the parasitic weed striga. After many years, a successful strain was developed which has helped prevent famine and ensure food security [14]. In addition to establishing and supporting partnerships, USAID's biotechnology efforts include sponsoring developing world students for U.S. graduate degrees and supporting agricultural education in participating countries. USAID also helped develop India's Department of Biotechnology. In addition to assisting with scientific capacity, USAID works with nations to build regulatory capacity to ensure safe biotechnology practices. Each of these types of efforts--building partnerships and collaborations, supporting education in the U.S. and in-country, building institutional capacity, and researcher exchanges--could be extended to nanotechnology.

Another possible approach for USAID is to foster public-private alliances between developing nations and U.S. companies. USAID's Global Development Alliance has successfully established hundreds of such alliances [15]. For example, to help reduce the digital divide, USAID allied with Cisco Systems to establish Networking Academies in over 40 developing nations, resulting in thousands of graduates [16].

In recent history, USAID has done a poor job at building scientific capacity in developing nations, primarily because of a decline in technical expertise in the agency [17]. Unless USAID reorganizes itself to include more technical experts, it is better for the agency to provide the incentives needed to overcome the existing barriers to nanotechnology research and development in the developing world. Although USAID is not the most technologically sophisticated U.S. agency, it is the most capable agency with respect to development, which makes it the best positioned agency to oversee the infusion of nanotechnology into development.

MCC is a new aid agency which offers unique opportunities for nanotechnology. Unlike USAID, MCC has a screening process for aid candidates, and currently relatively few nations are eligible for aid [18]. MCC seeks to reduce poverty through sustainable economic growth, and it does so through multi-year investment plans known as Compacts, which are managed primarily by the developing nation. Compacts typically involve hundreds of millions of dollars and therefore can make a significant impact on a developing nation. Nanotechnology has not been incorporated into any Compacts, but the reason MCC is enticing as a nanotechnology infusion vehicle is because an eligible nation could develop a Compact with the goal of building an independent nanotechnology research or manufacturing sector. Moreover, Compacts can take multi-

faceted approaches, so a nano-oriented Compact could combine education, research, domestic industry, and regulatory capacity all at once.

As discussed above, the current patent system is likely to complicate many of these and other efforts to assist the global poor through nanotechnology. Patent exemptions for innovations with beneficial humanitarian applications or innovative classes of patents that reward innovations according to their contribution to assisting the global poor would help to overcome some of these barriers [19]. Patents have been a major obstacle in developing nations with regards to biotechnology. To ensure that nanotechnology can be fostered in developing nations it is essential that intellectual property barriers are minimized.

4 RECOMMENDATIONS

The most effective and beneficial way for U.S. policy to encourage nanotechnology's contribution to resolving the problems of global poverty and development is through targeted research partnerships and collaborations fostered and supported by USAID, as well as through MCC research Compacts focused on building sustainable research or manufacturing capacity.

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