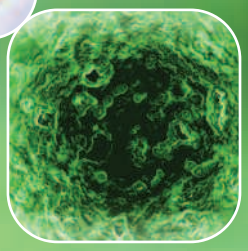
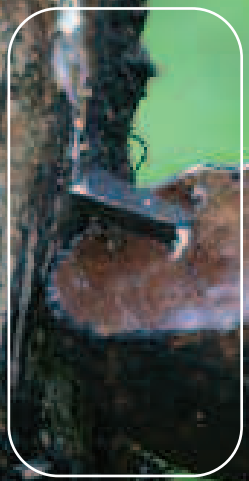
Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks



NANOTECHNOLOGY, COMMODITIES & development

Workshop Summary



Meridian Institute
Connecting People to Solve Problems

29 - 31 May 2007
Rio de Janeiro, Brazil

table of contents

[1] Executive Summary

Nanotechnology refers to a wide range of technologies that measure, manipulate, or incorporate materials and/or features with at least one dimension between approximately 1 and 100 nanometers (nm). Such applications exploit the novel properties that result from the nanoscale components' unique physicochemical and surface properties.

Both the public and private sectors in developed and developing countries, including developing countries with strong research and development capacity such as Brazil, China, India, and South Africa, are investing heavily in nanotechnology research and development. Despite rising nanotechnology investments and a proliferation of applications, only a limited number of people are exploring the linkages between nanotechnology and critical human development needs.

To close the gaps between people working on nanotechnology and those working on international development, Meridian Institute convened the Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks (GDNP) with the following goals:

[1] Raise awareness about the implications of nanotechnology for the poor;
[2] Catalyze actions that address specific opportunities and risks, especially those of significance to developing countries; and
[3] Identify ways that science and technology can play an appropriate role in the development process.

As one of several activities in the GDNP process,[1] Meridian Institute convened the International Workshop on Nanotechnology, Commodities, and Development (Commodities Workshop) on 29-31 May 2007 in Rio de Janeiro, Brazil to explore the linkages between various types of nanotechnology applications, commodities, and commodity markets, as well as related opportunities and risks for commodity producers, workers, consumers, communities, and governments in developing countries.

Ninety-five of the 141 developing countries derive at least 50 per cent of their export earnings from commodities.[2] UNCTAD estimates that a total of two billion people—a third of the global population—are employed in commodity production, half of those in agriculture.[3] Additionally, many developing countries that are highly dependent on commodity exports as a primary source of revenue appear low on the United Nations Development Programme's Human Development Index.

Nanotechnology applications are being developed that could impact global markets for agricultural, mineral, and other non-fuel commodities.[4] Some applications could increase or decrease global demand for specific commodities or create new or wider markets for commodities. Commodities Workshop participants from developed and developing countries and with a broad range of perspectives and expertise discussed the range of challenges faced by commodity-dependent developing countries (CDDCs), the extent to which nanotechnology may present opportunities for addressing these challenges, and the risks and other issues that need to be addressed in relation to specific commodity markets and specific nanotechnology applications.[5]

Participants began the workshop by reviewing technical characteristics of specific nanotechnology applications or classes of applications, which are summarized in Section 4, in the following commodities sectors:

- Agriculture and food – Participants discussed nanotechnology-based applications, including sensors, pesticides and fertilizers, and packaging materials, that are available or being developed to improve the productivity, affordability, predictability, and quality of agricultural production, as well as the ability to store and track the distribution of agricultural products.
- Mining and minerals – Participants discussed nanoscale formulations of metals and minerals with unique properties that may make them useful for products and processes in chemicals, electronics, biomedical, automotive, energy, and other industries. A number of examples of consumer health care products incorporating metal nanoparticles were discussed, including antimicrobial wound dressings, household appliances, air and water filters, and sunscreens.
- Fibers and textiles – Participants discussed nanotechnology-based production of synthetic fibers and yarns with enhanced strength, toughness, durability, conductivity, and

---

[1] More information on Meridian Institute is available at http://www.merid.org. More information on our activities involving nanotechnology, including Commodities Workshop materials, is available on our Nanotechnology Portal, http://www.merid.org/nano.

[2] South Centre, (2005) "Problems and Policy Challenges Faced by Commodity-Dependent Developing Countries (CDDCs)," Geneva, Switzerland.

[3] United Nations Conference on Trade and Development, (2005) "Trends in World Commodity Trade, Enhancing Africa's Competitiveness and Generating Development Gains." Report by the UNCTAD secretariat for the 2nd Extraordinary Session of the Conference of African Union Ministers of Trade, 21–24 November, 2005, Arusha, Tanzania.

[4] South Centre, (2005) "The Potential Impacts of Nano-Scale Technologies on Commodity Markets: The Implications for Commodity Dependent Developing Countries," Geneva, Switzerland.

[5] To inform these discussions, Meridian provided the following two background papers: Commodities, Development, and Development and Commodities, Development, and Technology. Meridian also developed an online Nanotechnology and Commodities Database cataloging specific nanotechnology applications, available online at http://nanoandcommodities.wordpress.com/.

other properties, as well as nanotechnology treatments for conventional fabrics to improve breathability, stain resistance, water resistance, and other surface properties.
- Rubber, plastic, and composite materials – Participants discussed nanotechnology-based additives, including naturally-occurring mineral clays with nanoscale structures, that can be used to add value and improve the mechanical, thermal, and other physiochemical properties of rubber, plastic, and composite materials.

With information on the challenges faced by CDDCs and the range of relevant nanotechnology applications, participants explored the complex linkages between commodities, development, and technology and expanded their discussions to a set of cross-cutting issues, as described in Sections 6, 7, and 8. The cross-cutting issues discussed included:

- Product research and development – Participants discussed the stages of development, as well as the speed of development of specific nanotechnology applications and classes of nanotechnologies. Participants pointed out that several developing countries, including middle-income developing countries with significant research and development capacity as well as smaller developing countries, are conducting cutting edge nanotechnology research to support their commodity-based industries.
- Environment, human health, and safety risks – Participants identified the need for additional research (and funding for research) on the potential environmental, human health, and safety risks of nanoparticles and nanomaterials. Participants also suggested a need for risk management approaches.
- Socio-economic issues – Participants discussed the potential for some nanotechnology applications to increase demand for certain commodities in new and wider markets or to provide low-risk opportunities for diversification of exports or for moving up the production value-chain by enhancing export commodities with nanotechnology additives, coatings, or processes. They also discussed the potential for other nanotechnology applications to displace demand for some commodities could worsen the socio-economic position of workers involved in the production and trade of those commodities. Although some felt that nanotechnology will impact demand incrementally and over time, others cautioned that the impacts can arrive suddenly for the poorest people who do not have the tools to anticipate or adapt to market changes.
- Ethics – Participants discussed the risk of a North-South and South-South nanotechnology divide. Some participants mentioned that poor communities are less likely to see direct benefits and more likely to fall further behind or suffer negative consequences from new technology introductions.
- Intellectual property rights and access – Participants discussed the potential impact of patents on the ability of developing countries to access new technologies and to benefit from them economically. Participants discussed the potential for excessive control over materials due to broad nanotechnology patents on nanoscale versions of conventional and natural materials. Some participants expressed concern that the increasing consolidation and integration of multinational companies and the potential for greater concentration of control over nanotechnologies could have far-reaching implications, including limitations on developing countries to access and benefit from new technologies.
- Public participation and engagement – Most participants felt that a broader range of organizations should be involved in the discussions on nanotechnology. In particular, they identified a number of international organizations involved in issues regarding commodities, development, and poverty alleviation that should be made aware of nanotechnology and its ties to commodities and development.
- Governance – Participants discussed the current status and on-going needs of governance structures for promoting pro-poor nanotechnology innovation strategies and providing risk assessment and management. Participants also discussed the adequacy of existing mechanisms and strategies to help developing countries anticipate and adjust to changes in commodity markets that may be caused by the introduction of nanotechnology. Participants discussed specific monitoring, analysis, forecasting, research, policy development, and strategies and mechanisms that may be needed to address these governance needs.
- Capacity building – Participants discussed capacity building that ensures any technology adoption is sustainable and appropriate for meeting development needs.
- International collaboration and cooperation – Participants identified specific opportunities for collaboration and cooperation, as described in Section 9 "Next Steps."
- Scalability, delivery, and sustainability – Participants discussed a range of nanotechnology applications relevant to commodity production in developing countries.

The workshop helped create new and unique connections between communities of people and resulted in important insights that will inform future multi-stakeholder discussions on nanotechnology and development. Workshop participants identified follow-up actions, summarized in Section 9, that Meridian Institute and others are now pursuing, including:

- Developing and disseminating more robust general information about nanotechnology, commodities, and development through publications and websites;
- Improving resources to help developing countries and commodity producers identify and anticipate the potential effects of specific nanotechnologies on demand for agricultural, mineral, and other commodities;
- Organizing additional workshops on topics pertinent to nanotechnology and development (e.g., nanotechnology, energy, climate change, and development; technological convergence and development); and
- Exploring and addressing nanotechnology governance, especially those issues of most significance and interest to developing countries.

Although these activities are focused on issues related to nanotechnology, commodities, and development, they also set the stage for future discussions about other sectors (e.g., energy and healthcare) and other broader issues, such as nanotechnology governance.

For questions about the Commodities Workshop or the GDNP, please contact:

Todd Barker
Partner
Meridian Institute
Phone: +1 802 899 2625
Email: tbarker@merid.org

Rex Raimond
Mediator
Meridian Institute
Phone: +1 970 513 8340 x230
Email: rraimond@merid.org

[2] Introduction

Nanotechnology encompasses a broad range of tools, techniques, and applications that manipulate or incorporate materials at the nanoscale (a nanometer is one billionth of a meter) in order to yield novel physical (e.g., size, shape), chemical (e.g., reactivity, conductivity), and surface (e.g., porosity, reflectivity) properties that do not exist at larger scales. Nanotechnologies are being developed for and applied to production and products across a range of sectors and industries (e.g., water, energy, medicine, agriculture, mining, textiles) and are creating a range of potential opportunities and risks for developing countries.

Some people have identified nanotechnology as a promising area of technological advancement and innovation for commodity dependent developing countries (CDDCs) and developing countries in general because it may enable new or improved materials, products, and processes that are more efficient, effective, and/or inexpensive than those currently available. Additionally, nanotechnology may increase production capacity by enabling manufacturing processes that have modest capital, land, labor, energy, and material requirements or be used to add value to existing export commodities and goods, potentially enabling developing countries to engage in a number of new markets for novel nano-enhanced materials and production processes.

Other people have expressed concern that the same characteristics that make nanotechnology potentially suitable for developing countries also raise the possibility that it could displace commodities, labor, and industries and worsen the overall economic position of developing countries. A growing number of institutions have also expressed concerns that nanoscale materials could pose risks, including risks to human health and the environment, which might be challenging for developing countries to identify and manage.

Both the public and private sectors in developed and developing countries are investing heavily in nanotechnology research and development. More than 20 countries, including developing countries such as China, South Africa, Brazil, and India, have national nanotechnology programs, and many more are developing or expanding nanotechnology research and development capacity. The collective public and private sector investment in 2005 was approximately USD10 billion, up 10% compared to 2004.[6] In addition, the number of patents on nanotechnology-related inventions (including those from developing country researchers),[7] scientific literature citations (now up to 12,000 publications per year),[8] and nanotechnology-based products reaching the market are skyrocketing globally.

With nanotechnology investments continuing to rise and applications proliferating, awareness and understanding regarding the implications of nanotechnology for developing countries is increasing. However, this awareness is still generally limited – few people involved in nanotechnology are considering development issues; few people involved in the development community are considering the potential role of nanotechnology in addressing critical development needs. These gaps are a significant concern, as current decisions in both developed and developing countries may result in policies, practices and systems that can have long-term impacts on the role of nanotechnology in helping to address specific development needs.

To address these gaps, the Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks (GDNP) was established with the following goals:

[1] Raise awareness about the implications of nanotechnology for the poor;
[2] Catalyze actions that address specific opportunities and risks, especially those of significance to developing countries; and
[3] Identify ways that science and technology can play an appropriate role in the development process.

During the past three years, Meridian Institute has pursued these goals through a variety of activities that have included, for example: convening meetings to identify the core issues at the nexus of nanotechnology and development; distributing timely and balanced information through our Nanotechnology and Development News service; speaking about nanotechnology and development at conferences; catalyzing and supporting collaborations and actions focused on specific opportunities and risks. Detailed overviews of these past and on-going GDNP activities can be found at http://www.merid.org/nano.

As part of the GDNP process, Meridian Institute convened the International Workshop on Nanotechnology, Commodities, and Development (Commodities Workshop) on 29-31 May 2007 in Rio de Janeiro, Brazil to explore the linkages between various types of nanotechnology applications, commodities, and commodity markets, as well as related opportunities and risks for commodity producers, workers, consumers, and governments in developing countries.

Discussions at the Commodities Workshop focused, in particular, on:

[1] Examining nanotechnology applications that are effecting or may effect agricultural, mining, and other non-fuel

[6] Holman et al., "*The Nanotech Report, 4th Edition*." (New York, NY: Lux Research Inc., 2006)
[7] Kshitij Aditeya Singh, "*Intellectual Property in the Nanotechnology Economy*." (Stirling, UK: Institute of Nanotechnology, 12 January 2007)
[8] Vicki Colvin, "*Responsible Nanotechnology: Looking Beyond the Good News*." (EurekAlert, November 2002)

commodity markets;

[2] Identifying mechanisms to anticipate, measure, analyze and address the impact of nanotechnology applications on commodity-dependent developing countries; and

[3] Catalyzing actions that could proactively address potential opportunities and risks associated with shifting commodity markets resulting from nanotechnology research and development.

Workshop participants discussed issues at the intersection of commodity dependence, development, and nanotechnology, in addressing development challenges in commodity-dependent developing countries. Discussions focused on a range of issues including socio-economic issues, trade, intellectual property rights, governance, production and distribution of technology, and others.

With a shared understanding of this broader context regarding commodity-dependence, development, and technology, participants discussed to what extent nanotechnology presents opportunities for addressing the challenges of commodity-dependent developing countries (CDDCs) as well as the risks and other issues that need to be addressed in relation to specific commodity markets and specific nanotechnology applications. Participants also discussed existing mechanisms and strategies that are available to help developing countries anticipate and address changes in demand for commodities. Based on this discussion, participants identified gaps and the possible need for new mechanisms that may be needed with the emergence of nanotechnology.

Workshop participants came from developed and developing countries and brought a mix of backgrounds, expertise, and interests. The Commodities Workshop agenda is provided in Attachment 1, and the participant list is provided in Attachment 2. Workshop participants identified and explored critical issues related to the opportunities and risks of nanotechnology for commodities and commodity-dependent developing countries; their discussions were not aimed at seeking consensus. This workshop summary describes key insights generated during workshop discussions. Comments are

[3] Background about Commodities, Development, and Nanotechnology

The term "commodities" often refers to "undifferentiated, widely traded raw materials and agricultural products that are traded principally on the basis of price."[9] Ninety-five of the 141 developing countries derive at least 50 percent of their export earnings from commodities.[10] In 2003, fifty-four of those countries depended on non-fuel commodities for more than half of their export earnings (e.g., copper and zinc account for 61 per cent of Zambia's export earnings; cotton makes up 72.7 per cent of Mali's earnings)[11] The United Nations Conference on Trade and Development (UNCTAD) estimates that a total of two billion people—a third of the global population—are employed in commodity production, with half specifically employed in agricultural production.[12]

Although the use of natural resources and production of commodities may contribute to economic development and enhanced public welfare, many of the developing countries that are highly dependent on commodity exports as a primary source of revenue also appear low on the United Nations Development Programme's Human Development Index. Reliance on a narrow range of commodities for revenue can be risky for countries and producers because internationally traded commodities have shown long-term real price declines and sharp short-term price fluctuations and have been associated with declining terms of trade, greater debt insecurity, and challenges with macroeconomic planning and sustainable economic and human development planning.

Among many other factors, science and technology may have a role to play in helping commodity dependent developing countries address some of their challenges. The development of indigenous technological capacity has often been considered a key determinant of economic growth and poverty reduction by enhancing the ability to improve efficiency of commodity production and produce higher value products; however, people also point to previous introductions of new technologies that have had negative consequences for commodity producers in developing countries who, for instance, did not have the opportunity to use technologies to generate efficiency gains or add value, or who could not compete against synthetic substitutes for their products.

Nanotechnology applications are being developed that could impact global markets for agricultural, mineral, and other commodities. Some applications of nanotechnology could make production more efficient, some applications could help producers move up in the product value chain or create new market opportunities, while others could create competitive substitutes for specific commodities. The broad range of relevant nanotechnology applications could have potentially far reaching socio-economic and other effects in developed and developing countries. The dependence of many developing countries on only one or two commodities is likely to accentuate the socio-economic effects resulting from changes in commodity markets in comparison to countries with more diversified economic bases.

Given the complexity of the linkages between the development of nanotechnology applications, commodities, and international development, Meridian Institute, through the Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks (GDNP), convened the Commodities Workshop to provide a venue for people with diverse expertise and viewpoints to discuss the potential opportunities and risks of nanotechnology in relation to commodities and commodity-dependent developing countries. In preparation for the workshop, Meridian Institute developed two background papers and a complementary online database:

- *Nanotechnology, Commodities, and Development* – This paper provides a brief introduction to issues at the intersection of commodity dependence, development and technology; general information regarding the opportunities and challenges nanotechnology offers for developing countries and, in particular, commodity-dependent developing

[9] Thomas F. O'Herron, ed., Terms of Trade: The Language of International Trade Policy, Law and Diplomacy (Washington, DC: International Advisory Services Group, 1999).
[10] South Centre, "Problems and Policy Challenges Faced by Commodity-Dependent Developing Countries (CDDCs)," in Trade-Related Agenda, Development and Equity (T.R.A.D.E.) Analysis Series (Geneva: 2005).
[11] Olivier Matringe, "Commodities at a Glance: Definitions and Importance of Commodities for Developing Countries" (paper presented at the University of Dar-es-Salaam Study Tour, Geneva, April 18-27 2006).
[12] UNCTAD, "Trends in World Commodity Trade, Enhancing Africa's Competitiveness, and Generating Commodity Gains" (paper presented at the African Union Extraordinary Conference of Ministers of Trade on African Commodities, Arusha, Tanzania, November 21-24, 2005).

countries; descriptions of commodity markets that are important to many developing countries (e.g., agriculture, mining and minerals, textiles, and rubber and composites); an overview of nanotechnology applications relevant to those sectors; and, specific examples of relevant nanotechnology applications.

- *Commodities, Development, and Technology* – As a supplement to "Nanotechnology, Commodities, and Development," this paper provides an overview of commodity markets, commodity dependence and poverty; the history, trends, and key issues in global commodity markets and how these issues affect commodity-dependent developing countries; and key issues at the intersection of commodity dependence, development, and technology.

- *Nanotechnology and Commodities Database* – An online database cataloging specific examples of nanotechnology applications relevant to agricultural, mining and mineral, fiber and textile, rubber and composite, and other commodities.

Meridian Institute also provided participants with two additional background papers written by other organizations.

- *Overview of the Situation of Commodities in Developing Countries* – Written by the Common Fund for Commodities, this paper provides information on the problems faced by commodity producers in developing countries.

- *The Potential Impacts of Nano-Scale Technologies on Commodity Markets: The Implications for Commodity Dependent Developing Countries* – Written by the ETC Group for the South Centre, this paper provides a brief introduction to nanoscale technologies and examines their potential impacts on commodity dependent developing countries.

These materials, as well as the four presentations described below, are available from the Commodities Workshop website at: http://www.merid.org/nano/commoditiesworkshop/.

[4] Nanotechnology and Commodities

The workshop began with four brief overview presentations by participants familiar with specific nanotechnologies that may affect commodities and commodity markets in developing countries. These presentations included an overview of existing frameworks for understanding and categorizing nanotechnology applications in terms of their complexity or stage of development and emphasized specific applications that may affect production and demand in the following commodity sectors:

- Agriculture and food;
- Mining and minerals;
- Fibers and textiles; and
- Rubber, plastic, and composite materials.

The applications highlighted were not meant to be indicative of the full range of nanotechnology applications currently available or in development that may affect commodities and commodity markets, nor of the full range of commodities on which developing countries are dependent. These examples were intended primarily to illustrate the differences in the types of applications that may affect commodities and commodity markets, as well as the differences in their respective potential effects on supply and demand for specific commodities. Additional examples of nanotechnology applications that may affect each commodity sector are described in the background paper, "Nanotechnology, Commodities, and Development," and in the online Nanotechnology and Commodities Database.

[4.1] Agriculture and Food

Nanotechnology applications are available and being developed to improve the productivity, affordability, predictability, and quality of agricultural production, as well as the ability to store and track the distribution of agricultural products. More specifically, some nanotechnology applications may improve agricultural productivity by increasing crop yields, decreasing crop losses and post-harvest losses, increasing the acreage available for farming, reducing energy and water demands, and improving the effectiveness of fertilizers, pest control, and other inputs. Some technologies can also potentially enable the use of land previously unsuitable for agricultural production and create opportunities for new value-added products, such as functional foods and biofuels, based on agricultural commodities.[13]

Nanosensors

Nanotechnology may enable new sensor technologies that enable farmers to more effectively monitor environmental and crop conditions (e.g., soil quality, moisture levels, temperature, plant health indicators), improving their ability to determine the best times for planting and harvesting crops, as well as the levels of fertilizers, pesticides, herbicides, and other treatments that need to be administered given specific environmental conditions. Such technologies could increase agricultural production by increasing crop yields, while reducing input requirements. Nanotechnology-based sensors can also be used to detect the presence of pathogens, chemicals, and other contaminants in food or to identify and analyze different indicators of food quality. One such technology described at the workshop is the so-called Electronic Tongue, a nanosensor device that provides quantitative analysis of multiple flavor components in a given food, the results of which can then be compared to data about known consumer likes and dislikes. The higher sensibility of such a nanosensor compared to conventional sensor technology may enable the food and beverage industry in developing countries to more easily make quality improvements to their products and to identify markets with tastes and preferences suited to their products.

Nano-Pesticides and Fertilizers

There are a number of nanotechnology-based agricultural chemical products currently available or in late stages of development. These include pesticide and fertilizer formulations containing nanoscale ingredients, which are said to be more stable, to dissolve more easily in water, and to optimize the desired effect of the chemical. Additionally, nanoscale structures such as nanotubes can function as delivery vehicles for pesticides and other agricultural chemicals that require controlled release. Also, nanoporous materials such as zeolites can be used to improve the stability of agricultural chemical suspensions, as well as aid slow release and controlled absorption. These technologies may allow lower quantities of chemicals to be used while, simultaneously, improving the effectiveness of lower doses.

Nano-Packaging Materials

Nanocomposite packaging materials are currently available and being developed for improving the preservation and storage (shelf life) of fresh foods and preventing microbial contamination of stored food.

[13] US Department of Agriculture, "Nanoscale Science and Engineering for Agriculture and Food Systems," ed. Corinne Johnson Rutzke (2003).

For example, Embrapa, Brazil's national agricultural research organization, has been developing an edible food coating made from chitosan, a material derived from the shells of crustaceans, to protect perishable foods from spoilage, dehydration, and loss of texture and flavor.

Functional Foods

Nanotechnology research and development are being applied to enhance taste, color, and texture of foods, as well as enrich foods with vitamins and nutrients. For instance, German company Aquanova is marketing a solution containing nanoparticles that is intended to help food manufacturers easily add antioxidants into food and beverage products. These applications may create opportunities to add value to commodity products, but they may also create substitutes for agricultural ingredients exported by developing countries.

Nano-Processing for Higher Value Products

Some nanotechnology applications may enable the use of agricultural commodities as inputs for higher value products, potentially creating new markets for these commodities in some cases. For example, new nanostructured catalytic materials may enable higher outputs of biofuels and other agriculturally-derived chemical products at lower prices.

[4.2] Mining and Minerals

Nanoscale metals and minerals have unique properties that do not exist at the bulk scale, making them useful for new products and processes in the chemicals, electronics, biomedical, automotive, energy, and other industries. Accordingly, growing demand from these industries is creating new markets for the production of nanoscale metals and minerals. Conversely, advancements in non-metal nanomaterials, such as carbon nanotubes, that have similar or superior properties to existing metal and mineral may result in substitution of these metal and mineral inputs with these new nanomaterials.

A number of examples of consumer and health care products incorporating metal nanoparticles were presented. These examples included an antimicrobial wound dressing, household appliances, and air and water filters containing silver nanoparticles, a home pregnancy test containing gold nanoparticles, and sunscreen lotions containing titanium dioxide or zinc oxide. Also presented as examples were golf clubs in which fullerenes have been used to replace conventional titanium and racing bicycles with frames that contain carbon nanotubes and are lighter weight and 20 times stronger than steel frames.

[4.3] Fibers and Textiles

Nanotechnology can enable both the creation of new fibers and textile materials and the enhancement of existing natural and synthetic fibers and materials. In fiber and textile manufacturing, nanotechnology can generally take two forms – fiber and yarn production and treatments for fabric finishing. Nanotechnology applications for fiber and yarn production involve using nanoscale materials, such as carbon nanotubes, to synthesize high-performance fibers with superior mechanical properties such as strength, toughness, durability, conductivity, etc. These nanofibers can be used to make improved fabrics for apparel, carpeting, furniture, and other conventional textile markets or to make products for new markets, such as electronic fabrics for actuation and energy storage, materials for tissue engineering, filter media, or wound dressings. Nanotechnology fabric finishing involves using a nanotechnology treatment on a conventional natural or synthetic textile substrate to improve the textile's durability, strength, water-resistance, or other properties.

Three examples of nanotechnology applications for fiber production were presented. Korean company Mipan has developed Nano Magic Silver, an antimicrobial composite fiber containing silver nanoparticles for use in such applications as sports apparel, underwear and socks, bedding and towels, personal sanitary products, and hospital gowns and scrubs. U.S. filtration technology developer Donaldson Company, Inc. as developed a proprietary method based on a process called electrospinning for producing nanofibers "webs" used as filtration media for commercial air filtration cartridges. Czech nanotechnology company Elmarco has developed a technology called Nanospider that enables industrial production of nanofibers for use in filtration, healthcare, construction and automotive applications, and others.

Several examples of nanotechnology fabric treatments were also presented. Gore-Tex, a material developed by U.S. company W. L. Gore & Associates, is a nanoporous membrane that can be incorporated between layers of fabric to produce garments that allow moisture vapor from the body to escape but prevent water, oil, and other substances from penetrating the fabric. U.S. company Nano-Tex markets a line of textile surface treatments that bond nanoscale polymeric films to the surface of textile fibers to produce water and stain repellant properties.

[4.4] Rubber, Plastic, and Composite Materials

Nanotechnology-based additives can be used to add value and improve the mechanical, thermal, and other physiochemical properties of rubber, plastic, and composite materials. Nano-additives can include naturally-occurring mineral clays with inherent nanoscale structures, such as montmorillonite and halloysite, and natural or synthetic nanoparticles, such as zeolites, carbon nanotubes, and carbon fullerenes. The addition of nanomaterials can enable the use of plastic and rubber composites in new and broader markets, but also reduce the amount of composite material needed in a given application. Additionally, nanotechnology can enable the development of new materials that can replace natural rubber and commodity plastics (i.e., polyethylene, polypropylene, PVC) that are currently used. Several examples of nanocomposite materials were presented to illustrate the range of potential property

enhancements and applications enabled by the addition of nanomaterials to conventional plastics, composites, and rubber.

Nanoclays can be added to a range of polymer materials to enhance the materials' physical and mechanical properties. For example, U.S. company Nanocor has demonstrated in experiments that nanocomposites of Nylon 6 polymer and montmorillonite nanoclay exhibit greater resistance to tension, flexion, and heat and lower gas permeability as the proportion by weight of nanoclay increases. Similar improvements in strength have also been shown for composites of nanoclays and polypropylene, cyclobutanediol (CBDO) copolyester, nitrile rubber (a synthetic material often used in car tires), and sheet molding compound (SMC) used for a variety of applications.

Nanomaterials can also improve the barrier properties and flame retardancy of many polymer materials. U.S. company InMat, Inc. has developed a technology platform called Nanolok™ for manufacturing clay-based nanocomposite coatings for reducing the permeability of polyester, acrylic, nitrile, and other polymer materials, making them suitable for such applications as tires, sports balls, gloves, hoses, rigid and flexible packaging, and others. The addition of organic nanoclays has also been shown to reduce the formation of char on plastic power cables and the density of smoke from the burning or decomposition of plastics.

NaturalNano, Inc., a U.S. company specializing in naturally-occurring halloysite clay, is developing ways to use the clay's natural nanotubular structure to create nanocomposite materials with novel absorption properties. For example, the clay nanotubes could be filled with various active agents, such as microbicides, fertilizers or conductive particles, and deployed in composite materials for agricultural, healthcare, household, electronic, and other products.

[5] Commodities, Technology, and Development

Following the presentations on specific nanotechnologies and throughout the rest of the workshop, in both plenary sessions and workgroups, participants discussed the complex linkages between commodities, development, nanotechnology, and a range of contextual issues, which are described in Section 6. Through the progression of these discussions, participants began reviewing the potential effects of specific nanotechnologies and classes of nanotechnologies in the context of these broader issues pertaining to the situations of commodities and CDDCs.

To set the context for these discussions, two participants knowledgeable about the role of commodities and commodity markets in developing countries and the range of issues pertaining to commodity-dependence, technology, and development made brief presentations.

The first overview described how, due to the undifferentiated and global nature of commodities, commodity-producing countries face several persistent challenges in international markets, including long-term declining commodity prices, short-term price volatility, and declining terms of trade. It further described how increasing vertical and horizontal integration by and consolidation among large multi-national corporations (MNC) and developed country enterprises have given these groups more bargaining power than commodity producers over the price of commodities, often resulting in lower profits for producers and lower earnings for commodity-exporting countries.

The overview identified several opportunities and challenges that technology poses for commodity producers and CDDCs. On the one hand, technology can provide commodity producers with opportunities to diversify their export portfolios, produce and export value-added products with lower price risks and greater profit potentials, and access new and wider markets. On the other hand, developing countries may be subjected to further economic and social costs if they lack the capacity to adopt new technologies or if new technologies facilitate greater integration and consolidation of MNCs and developed countries in commodity markets.

The second overview suggested several contextual issues relevant to identifying, evaluating, and managing the potential opportunities and risks of a technology for a developing country, including:

- How can fluctuations in demand for commodities resulting from a technology be anticipated and mitigated?
- How can price shocks resulting from a technology be managed after they have occurred?
- How will a technology affect the entire chain-of-production for a commodity?
- How will a technology affect access to and power in commodity markets?
- How will the opportunities and risks of a technology be distributed within and among countries?
- How can a technology be leveraged to connect producers with markets?
- What incentives can be offered to promote use of a technology?
- How can a technology be adapted instead of adopted?

In the section below, we summarize comments and perspectives on these and other contextual issues that are broadly applicable across the range of nanotechnology applications discussed at the workshop.

[6] Matrix of Technologies and Cross-Cutting Issues

Participants in GDNP meetings, most recently the International Workshop on Nanotechnology, Water, and Development,[14] have identified a range of cross-cutting issues at the nexus of nanotechnology and development that should be considered when evaluating the potential implications of nanotechnology and specific nanotechnology applications. While these issues may be generally applicable to technologies, the unique characteristics of nanotechnology may result in different considerations for each cross-cutting issue, which, in turn, could require new and different strategies for addressing these issues. In addition to being applicable to multiple technologies, these cross-cutting issues may also be relevant to multiple sectors important to international developing, including commodities, water, energy, and health. These issues may include, but are not limited to:

- Product research and development;
- Environment, human health, and safety risks;
- Socio-economic issues;
- Ethics;
- Intellectual property rights and access;
- Public participation and engagement;
- Governance;
- Capacity building;
- International collaboration and cooperation; and
- Scalability, delivery, and sustainability.

Meridian Institute staff have developed a matrix listing these issues. Table 1 (below) demonstrates this matrix and how these issues might apply to different sectors and classes of technologies within a sector. Appendix 3 provides definitions to clarify the distinguishing characteristics of these cross-cutting issues. Participants in the Commodities Workshop and other GDNP meetings have used the matrix to help guide and focus discussions on issues associated with specific nanotechnology applications or classes of technologies.

[14] The International Workshop of Nanotechnology, Water, and Development (Water Workshop) was convened by Meridian Institute through the GDNP on 10-12 October 2006 in Chennai, India to address the potential opportunities and risks of nanotechnology water treatment technologies for developing countries. More information about the Water Workshop, including background papers and meeting materials, is available at http://www.merid.org/nano/waterworkshop.





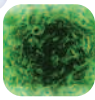


Figure 1. Matrix of Cross-Cutting Nanotechnology Issues and Sample Technology Categories

	Water																		Agriculture										Minerals	Textiles	Energy	Health
	Carbon Nanotube Technologies			Nanofibrous Filters			Ceramics and Adsorbents			Nanocatalysts			Magnetic Nanoparticles			...			Monitoring Devices			Packaging and Storage			Functional Foods			...						
Product research & development																																
Environment, human health, & safety ricks																																
Socio-economic issues																																
Ethics																																
Intellectual property rights & access																																
Public participation & engagement																																
Governance																																
Capacity building																																
International collaboration & cooperation																																
Scalability, delivery, & sustainability																																

[7] Cross-Cutting Issues

Following the presentations on nanotechnology applications, and throughout the workshop, both in plenary sessions and workgroups, participants discussed the complex linkages between commodities, development, and technology, including specific applications and classes of nanotechnology. During these discussions, participants explored how different cross-cutting issues (see section 4) may apply to different commodity sectors and classes of technologies within a commodity sector.

In the section below, comments and perspectives that are broadly applicable across the range of commodity sectors and nanotechnology applications discussed at the workshop are described. Table 2 (below) demonstrates how participants refined and expanded the matrix of cross-cutting issues (see Table 1) to address specific issues relevant to the topic of commodities sectors and developing countries.

[7.1] Product Research and Development

Participants discussed the stages of development (e.g., is the technology on the market, has it been field tested, lab tested, or in early research stages), as well as the speed of development (e.g., time it takes for the technology to move from the lab to the market) of specific nanotechnology applications and classes of nanotechnologies. Given the broad focus of the workshop on commodities, participants discussed product R&D in more general terms than during the preceding workshop (Nanotechnology, Water, and Development) when participants discussed cross-cutting issues in the context of very specific technology examples.

Participants pointed out that several developing countries, including middle-income developing countries with significant research and development capacity as well as smaller developing countries, are conducting cutting edge nanotechnology research to support their commodity-based industries. For instance, Brazil's agricultural research corporation, Embrapa, has formed a nanotechnology research unit and South Africa's mining research institute, Mintek, is collaborating with gold mining companies to explore production of nanoscale gold particles for new markets (e.g., catalysts and biomedical applications).

The participants with knowledge of nanoscience and technology felt that nanotechnology is probably not a technological revolution, but rather an evolution (e.g., synthetic fibers are replacing natural fibers, which is a trend that may be enhanced further by nanotechnology applications). This idea of an evolution of nanoscience and technology informed discussions on governance issues (see section 7.7).

[7.2] Environmental, Human Health, and Safety Risks

Throughout the discussions, participants commented on the lack of information regarding the potential environmental, health, and safety risks of the range of nanoscale materials that are on the market or are being developed for application in commodity production. There is a need for risk studies and the development of risk management approaches. Several participants pointed out that current government spending on nanotechnology risk research in developed and developing countries is a small fraction of R&D spending. Some participants wondered who would pay for risk assessment studies.

[7.3] Socio-Economic Issues

Participants discussed the potential for some nanotechnology applications to increase demand for certain commodities in new and wider markets or to provide low-risk opportunities for diversification of exports or for moving up the production value-chain by enhancing export commodities with nanotechnology additives, coatings, or processes. Participants distinguished between nanotechnology applications as substitutes and nanotechnology applications as complements to existing commodities.

The potential for other nanotechnology applications to displace demand for some commodities could worsen the socio-economic position of workers involved in the production and trade of those commodities. Taking copper as an example, The Energy and Resources Institute (TERI) of India is examining the potential impact of carbon nanotubes as replacements of copper wiring for power transmission and distribution, as well as potential new markets for nanoscale copper particles and applications of nanocomposites to enhance the quality of copper materials. For example, should carbon nanotubes substitute copper, the mining companies and their workers are most likely to feel the impact. The refining and smelting industries can more easily shift to engineering and processing other products. However, several participants felt that carbon nanotubes are not likely to have a big impact on the copper mining industry in the near term because, for instance, production of carbon nanotubes requires energy-inputs that are significantly higher than copper smelting. They felt that carbon nanotubes might find a niche market in the fiber optics industry, where they could become a competitive alternative. Some participants thought that nanotechnology may create new opportunities for copper (e.g., nanoscale copper with novel properties may become suitable for applications in microchips).

Some participants suggested that nano and other technologies should be assessed for social and economic impacts given these and other scenarios. Because national-level socio-economic impacts in developing countries might be difficult to predict – these impacts depend on the policies, systems, and practices of the country involved – initial studies might focus on the potential impacts on specific commodity sectors in specific countries. Participants shared anecdotal information and information based on existing studies about the impacts of technology on specific sectors. For instance, the South African government is working to attract R&D and capacity building investments by extractive industries that are already operating in South Africa and with businesses purchasing precious metals from South Africa. As a result, more processing and value-

addition takes place in South Africa and the clients receive higher value products. Other participants pointed out that value addition can also result in high unexpected costs (for instance, tanning leather in India has resulted in increased monetary revenues, but also additional environmental costs). In the context of potential socio-economic benefits and losses resulting from nanotechnology applications, participants briefly discussed regulatory approaches to establish compensation rights giving local people a fair share of profits resulting from commercial applications derived from local resources.

Participants noted that where nanotechnology may present opportunities for CDDCs, the poorest segments of the population in those countries might not be the one's to benefit socially or economically from those opportunities. Some suggested that this is in part due to the relative difficulties that these poor populations face in predicting and adjusting to market changes. Others suggested that concentrated ownership of technologies by large multi-national corporations could limit the benefits that commodity producers and commodity producing countries can reap.

Throughout the conversation, participants emphasized the important role of government economic development strategies. Developing countries' national development needs and strategies play a key role in determining whether and, if so, what role nanotechnology plays in domestic commodity production. Nanotechnology might create opportunities, for instance, to make commodities attractive for new markets thereby creating demand, but this is just one of many options. Nanotechnology may also pose risks, so information is needed to help inform policy and strategic decision-making.

Participants felt that it is important to track developments in nanotechnology and their potential impacts on commodities and commodity markets in order to inform decision-making by developing countries. Participants suggested that the UNCTAD INFOCOMM database should include information on advances in nanotechnology. Participants also suggested that "foresighting" (e.g., looking at potential demands and threats to commodity production in developing countries in 5, 10, or 20 years) would be very helpful as well as ongoing work to understand trends in science and technology and how they are impacting the poor. Some participants suggested developing scenarios to systematize the range of complex issues and inform innovation and other policies.

[7.4] Ethics

As GDNP dialogue participants have consistently recognized, the pace and pattern of nanoscience and nanotechnology research and development in the developing world is increasing and could lead to significant breakthroughs. Some participants, however, fear that the possibility remains that the majority of resources and expertise (in the North and South) may be applied to products and services that hold the most promising market potential in the North where the richest consumers live and not to products and services that would benefit poor populations either directly or indirectly.

Situations in which some developing countries like Brazil, China, South Africa, and India are racing ahead of their poorer neighbors in terms of technological development is sometimes referred to as a South-South divide. Such a South-South divide would result when some developing nations adopt leapfrog technologies and practices, and others do not (whether by mistaken choice or by circumstance), but also when the leapfrog nations work to meet the demands of the developed world consumer market and neglect to use these technologies to improve the conditions for those in poverty, both within their own borders and in their region as a whole.

Several participants argued for the need to focus policies, practices, and other interventions on the needs of poor people. They felt that it is not sufficient to speak about the impacts of nanotechnology on developing countries; some groups in developing countries may be perfectly able to benefit from new technologies. Action is needed to assist poor communities that are less likely to see direct benefits and are likely to fall further behind or perhaps even suffer negative consequences from new technology introductions.

[7.5] Intellectual Property Rights (IPRs) and Access

Participants discussed several issues related to IPRs and the impact of patents on the ability of developing countries to access new technologies and to benefit from them economically. Participants discussed the potential for broad nanotechnology patents on conventional and natural materials at the nanoscale, and the possibility that such patents could give patent owners excessive control over the use of nanoscale materials, including nanoscale versions of commodities. Participants also discussed the different potential implications of patents on nanotechnology products versus nanotechnology-based processes for producing or adding-value to products.

Some participants pointed to the increasing consolidation of multinational companies controlling the middle of the value-chain between raw commodities and finished products, as well as the increase in these intermediaries' levels of horizontal and vertical integration. They expressed concerns that the combination of consolidation and the potential for greater concentration of control over nanotechnologies could have far-reaching implications, including limitations on developing countries' and, in particular, poor peoples' in those countries, ability to access and benefit from new technologies. Some participants suggested that information about IP ownership should be tracked more closely, for instance by including it in future GDNP workshop background materials.

[7.6] Public Participation and Engagement

Most participants felt that a broader range of organizations should be involved in the discussions on nanotechnology. In particular, they identified a number of international organizations involved in issues regarding commodities, development, and poverty alleviation that should be made aware of nanotechnology, and its ties to commodities and development (see Next Steps section for more details).

Some participants felt that general awareness raising about nanotechnology is an important priority to give people in general, and decision-makers in particular, a better understanding of nanoscience and nanotechnology as well as its possible implications for developing countries.

As participants discussed the importance of generating information about nanotechnologies relevant to locally produced commodities, they also touched on the importance of access to information as an element of effective public engagement in decision-making. Especially in developing countries, access to information may be challenging if there is no reliable local infrastructure (e.g., Internet, cell phones, or even traditional mail delivery). Access to reliable information is a challenge where there is no infrastructure, electricity, or trained people to look for and interpret and ensure the quality of information.

[7.7] Governance

Governance and Innovation

Participants discussed whether nanotechnology R&D is being aimed at meeting the needs of poor people, or if nanotechnology can offer opportunities for poor countries to improve their economic conditions. Building on the overview presentations (see Section 4), participants gave a number of examples of nanotechnology applications that might benefit the poor. For instance, applications for: growing crops in dry and hot conditions (adapting to climate change), adding value to existing products (e.g., cotton with enhanced properties), creating protective clothing for (mine) workers, accident prevention in mines and other hazardous locations (e.g., sensors to detect gas pockets, wireless data transfer, remote monitoring, and airflow management), and remediation of contamination.

A broader issue regarding governance, innovation, and risk, is participants' observation that the technology is at an early stage of development, which means that there is still time to work on redirecting public research towards beneficial goals and away from potentially disrupting technologies. Practically, this means evaluating the potential risks and opportunities and via communication influencing the priority setting process in research. Several participants suggested that this would be a low cost and high return strategy to increase the likelihood of positive outcomes from nanotechnologies for the poor.

This requires that information dissemination should be done in two directions: 1) from the nanoscience and technology community (e.g., scientists, science funders) to the development community and 2) from the development community to the nanoscience and technology community.

Risk Governance

Participants commented on the lack of information regarding the potential environmental, health, and safety risks of nanoscale materials and the need for risk studies. Several participants pointed out that current government spending on nanotechnology risk research in developed and developing countries is a small fraction of R&D spending.

Participants suggested that access to information about the possible benefits and risks of specific applications is a critical element of strategic decision-making. The discussion about generating and accessing risk-related information revealed several challenges. In addition to the fact that risk research is severely under-funded, some types of useful information about risks may currently not be disclosed. For instance, risk information about pre-competitive products is not made public until the product reaches the market, and even publicly funded research sometimes requires that environmental and health impacts are not disclosed. There is a need for incentives to share information in a manner that balances business interests with public interest in transparency, efficiency, expediency, and informed decision-making.

Participants' views regarding appropriate risk management approaches differed. Some felt that a precautionary approach was required for new materials with new properties and unknown consequences, some felt that risk management approaches should differentiate between nanoscale materials (e.g., nanoclays) that consist of chemicals that are known to pose no, or limited, risks and those for which the properties and risks may not be known, and some felt that nanotechnology and nanoscale material applications would create alternatives for products that are much more harmful to environment and human health (e.g., conventional pesticides and herbicides) and that progress in nanoscience and nanotechnology should be encouraged because it will lead to more sustainable practices.

Governance and Economic Development

Participants discussed the adequacy of existing mechanisms and strategies to help developing countries anticipate and address changes in demand for commodities and specific actions and strategies that could help developing countries anticipate and adjust to changes that may result from nanotechnology applications affecting demand for commodities.

Discussions highlighted a need for governance strategies and mechanisms that help developing countries identify how nanotechnology applications may affect the entire production value-chain and the consolidation of market power. Participants discussed specific monitoring, analysis, forecasting, research, policy development,

and strategies and mechanisms that may be needed to address these governance needs.

Some participants felt that, regardless of whether nanotechnology is a revolution or an evolution in science, these developments may require a revolution in governance for the poor to benefit from technological opportunities or anticipate the changes that may be coming down the pike. These participants mentioned that poor people often do not have control over new technologies and are more likely to suffer negative consequences than to reap benefits. These participants felt that there is a need for governance structures and incentives to create benefits for the poor. Some felt that, for instance, if nanotechnology were to contribute to protective mine worker clothing and systems to prevent explosions in mines, regulation may be needed to ensure that these protections are actually used.

Information and Governance

Information, research, and governance are closely linked. Some participants suggested that policy makers should be able to orient applied research to impacts or prospects for sustainable development, so that research generates information that can be used by policy and other decision-makers in developing strategies and setting priorities.

Participants also mentioned that information sharing about local needs is a critical step in orienting research and development towards the needs of poor commodities. For instance, the Council for Scientific and Industrial Research (CSIR) in India has developed a web-based system to identify and communicate community-based needs. It might be possible to use similar approaches to identify commodity-specific needs, and make this information available to various networks that could help address needs. Participants stated the importance of understanding needs at a local level because, for instance, water, energy, or health-related needs may differ dramatically from place to place.

Participants identified a hierarchy of information needs:

I. Identify the problem or need that has to be resolved;
II. Identify possible solutions (including nano and non-nanotechnology enabled solutions);
III. Develop a strategy that includes short-term, medium-term, and long-term approaches for implementing solutions.

Levels of Governance

Several participants felt that governance issues should be given a home at the intergovernmental level, while also encouraging national governments to address these issues. Participants also suggested that there are appropriate roles for industry, commodity exchanges, civil society, social movements, and other groups at the local, national, regional, and/or international levels in governance of nanotechnology, including in developing and implementing specific governance strategies and mechanisms.

Participants mentioned examples of international processes that have effectively involved industry and civil society organizations (e.g., World Summit on the Information Society) or created trusted scientific expertise (e.g., the Intergovernmental Panel on Climate Change).

Some participants suggested regional governance initiatives could be developed as a first step. For instance, the EU may be creating a "nanotechnology observatory" to track and provide information about trends and developments in nanotechnology worldwide. Perhaps it would be feasible to create regional observatories in multiple regions that use a common methodology to assess technologies.

[7.8] Capacity Building

Participants emphasized the importance of capacity-building to ensure that any technology adoption is sustainable and that developing countries have the educated and trained staff and access to information to evaluate technologies and select the best available option(s) to meet their near and long-term needs. Some participants felt that countries at least need a local knowledge and scientific base to facilitate (nano)technology transfer, adaptation, and/or development. But they also mentioned that certain nanotechnology applications, for instance nanoclays for composite applications, are already on the market and may not be difficult to adapt or apply. It is possible to develop some products, for instance materials for nanosensors, locally with simple chemistry.

Several participants suggested that capacity building should consi st of such elements as:

- International, interdisciplinary, and inter-industry collaborations on education and training;
- Access to information to help developing countries assess the benefits and risks of specific technologies and select technologies that are most appropriate for them; and
- International dialogues on nanotechnology research and development that incorporate issues related to the social, economic, and political contexts of developing countries.

Some participants suggested, given the nature of the issues related to nanotechnology, commodities, and development, that initial capacity building efforts focus on politicians, researchers and academics, and economists. They also said a premium should be placed on identifying people that can train others. They indicated nanotechnology might present challenges in comparison to other capacity building efforts because of its multi-disciplinary nature. Participants suggested the substantive focus of capacity building efforts should initially be broad and include technical, socio-economic and policy dimensions with the goal of informing decisions

that may emerge regarding regulatory and governance issues (especially related to commodities). This work could be accomplished, in part, through on-going opportunities for face-to-face dialogue, interactive websites and web-accessible databases. Participants noted sensitivities related to who provides the capacity building (i.e., who is providing it and what are their motives).

[7.9] International Collaboration and Cooperation

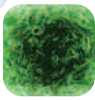
As described in the "Next Steps" section, participants identified specific opportunities for international collaboration and cooperation related to helping developing countries anticipate and address changes in demand for commodities due to nanotechnology.

[7.10] Scalability, Delivery, and Sustainability

Participants discussed a range of nanotechnology applications relevant to commodity production in developing countries. Given the broad focus of the workshop on commodities, participants did not discuss the scalability, delivery, and sustainability of specific technologies during this workshop.







[8] Updated Matrix of Cross Cutting Issues

Table 2 (below) demonstrates how participants refined and expanded the matrix of cross-cutting issues (see Table 1) to address specific issues relevant to the topic of commodities sectors and developing countries.

Table 2 – Updated Matrix of Cross-Cutting Nanotechnology Issues and Sample Technology Categories

		Agriculture														**Mining and Minerals**														**Textiles**														**Composites**													
		Sugar			Coffee			Soy			...					Gold			Silver			Copper			...					Cotton			Silk			Wool			...					Rubber			Plastic			...					
		Tech X	Tech Y	...												Nano Catalysts						CNT Wires								Nano Coating	Synthetic Nano-fibers																								
Research & development																																																							
Environment, health, & safety																																																						
Socio-economic issues																																																						
Ethics																																																						
Intellectual property rights & access	Patented?																																																					
	Product &/or Process Patent																																																				
	Market Concentration																																																					
	...																																																					
Public participation																																																						
Governance	Price and Price Stability																																																					
	Chain-of-Production																																																				
	Horizontal & Verical Integration																																																				
	...																																																				
Capacity building																																																						
International collaboration & cooperation																																																						
Scalability, delivery, & sustainability																																																						

[9] Next Steps

Participants identified follow-up actions and activities that ranged from technology- and sector-specific to national and international in scope, including:

- Developing and disseminating more robust general information about nanotechnology, commodities, and development through publications and websites;
- Improving resources to help developing countries and commodity producers identify and anticipate the potential affects of specific nanotechnologies on demand for agricultural, mineral, and other commodities;
- Organizing additional workshops on topics pertinent to nanotechnology and development (e.g., nanotechnology, energy, and development; technological convergence and development); and
- Exploring and addressing nanotechnology governance, especially those issues of most significance and interest to developing countries.

Several individuals expressed interest in following up on specific ideas. Next steps identified during the meeting are summarized below.

More Robust Information about Nanotechnology, Commodities, and Development

- Commodities Workshop Website
  http://www.merid.org/nano/commoditiesworkshop
  Meridian Institute will maintain a website where resources related to the Commodities Workshop will be made available. The website will include all the workshop materials, the workshop summary, pictures, presentations, and a nanotechnology and commodities database.

- Region Specific Resource Portals
  Meridian Institute is exploring collaborative opportunities with partners in different regions to make more robust sets of information about nanotechnology and specific geographic regions (e.g., India, Africa, Latin America) available through web portals that build on the Meridian Nanotechnology and Development News (NDN) service. These region-specific portals would enhance coverage of nanotechnology developments in each region and relevant development priorities in each region through NDN's daily news summaries. These portals would provide direct access to the following resources about nanotechnology developments and relevant development priorities in each region:
  - NDN summaries focused on each region;
  - Archives of NDN summaries focused on each region;
  - An advanced search function enabling customized searches of the archives by stakeholder group, application, implication, or any combination of those categories;
  - A "resources" website that can be sorted alphabetically or by organization type (e.g., academia, government, private sector, NGO, etc.) providing links to websites of organizations involved with nanotechnology in each region;
  - An interactive forum for users to discuss issues related to nanotechnology and each region.

Resources to Help Developing Countries, Commodity Sectors, and the Nanoscience and Technology Community Identify and Anticipate the Potential Effects of Nanotechnology on Demand for Commodities

- Overview Document on Nanotechnology, Commodities, and Development
  Based on participant suggestions, Meridian Institute has developed a short document designed to help decision-makers in developing countries and international organizations better understand: nanotechnology; its potential opportunities and risks for CDDCs; and the cross-cutting issues that should be considered in assessing opportunities and risks .[15] Many participants expressed support for translating this document into several languages and disseminating it to their networks, as well as local, regional, and international organizations, international research organizations (e.g., the Consultative Group on International Agricultural Research), companies, governments, media, educational institutions, civil society, and other groups.

- News Service Translations
  Meridian Institute, Embrapa and others are exploring the development of translations of Meridian Institute's Nanotechnology and Development News (NDN) into Spanish and Portuguese. NDN is a free daily news service covering the most important global developments at the nexus of nanotechnology, poverty alleviation, and the role of science and technology in development. These translations will make it easier for decision-makers in Spanish and Portuguese speaking countries to track the rapid developments in the fields of nanoscience and technology (both the benefits and risks) that could be critical to developing countries.

[15] This document is included with this summary as Appendix 4 and available as a stand-alone document for download at http://www.merid.org/nano/commoditiesworkshop.

- Research and Education
  In follow up to the workshop, some participants are exploring the development of a new interdisciplinary degree program that would look at the economic and development aspects of nanotechnology. Currently, no such programs exist and the workshop highlighted the need for this interdisciplinary approach.

Additional Workshops

Participants agreed that further sector-specific workshops relevant to nanotechnology and development would be valuable and are a unique approach that distinguishes the GDNP from other initiatives.

- International Workshop on Nanotechnology, Energy, Climate Change, and Development (Energy and Climate Change Workshop)
  Because of the significance of climate change and the importance of energy to addressing well documented human development challenges such as water and health, Meridian is planning to convene the International Workshop on Energy, Climate Change, Nanotechnology and Development. The workshop will explore the potential opportunities and risks of nanotechnology applications that are being developed, which may address challenges related to energy security and climate change. The workshop will provide an opportunity for participants with different areas of expertise to explore specific issues related to climate change and energy in developing countries, the role of nanotechnology in addressing these issues in developing countries, while also surfacing "cross-cutting issues" (i.e., issues that apply to multiple sectors). Immediately before the Energy Workshop Meridian proposes a 1-day workshop open to the public, which would focus in particular on nanotechnology applications relevant to energy and climate change issues. Audio and possibly video of the public workshop will be made publicly available via the Internet. If possible, Meridian will provide live coverage of the event via the web, with the ability for viewers to submit questions by email or instant messages.

- International Workshop on Nanotechnology, Health, and Development
  Next in the series of sector-specific workshops would be the International Workshop on Nanotechnology, Health, and Development, which will explore potential opportunities and risks of nanotechnology applications that may address health issues that are endemic in developing countries.

Governance

Several participants identified the need for raising awareness and increasing the importance of nanotechnology governance issues, as well as for more robust discussions about nanotechnology governance.

- International and Intergovernmental Nanotechnology Governance
  Several participants expressed interest in raising awareness and increasing the priority of addressing nanotechnology governance issues among international and intergovernmental organizations and processes such as UNCTAD, the International Labor Organization (ILO), the World Trade Organization (WTO), the Common Fund for Commodities, regional and sub-regional organizations (e.g., Andean Community, Mercado Común del Sur (Mercosur)), Regional Development Banks, and others.

- Global Dialogue on Nanotechnology Governance
  Participants identified a need for international discussions focused on developing countries' needs and priorities with regards to governance of nanoscale materials and nanotechnologies. Given the importance of governance issues, Meridian is planning to convene a global process on nanotechnology governance, which would:
  - Assess the current landscape of initiatives related to nanotechnology governance;
  - Clarify the definition of "governance" relative to nanotechnology; and
  - Based on this clarification, identify a governance framework through a collaborative process, involving developed and developing countries, that is broadly supported by the public and thought leaders in government, companies, NGOs, universities, international institutions, and donor organizations.

    The expected output from the dialogue includes a governance framework that addresses both opportunities and risks, is broadly supported by all sectors of society, responds to the needs of developing countries, and can inform decision making at national, regional, and international levels.

We expect that the outcomes of these activities will include, among others: publications in the areas of nanotechnology and energy, climate change, and health; issue specific collaborations in these areas; development of a nanotechnology governance framework; enhanced awareness about links between nanotechnology and development; new and enhanced networks; and enhanced capacity and expertise in developing countries.

[10] Conclusion

The Commodities Workshop confirmed that the complex issues emerging at the intersection of nanotechnology, commodities and development deserve greater attention from a wider array and number of stakeholders. The workshop enabled participants to begin identifying these issues and the range of institutions that will be needed to effectively anticipate and address them and created new and unique connections between communities of people that had limited interactions in the past Experts in commodities learned from nanotechnology experts, while nanotechnology experts gained insights into commodities and challenges in developing countries. These connections resulted in several important insights that will inform future technology and issue specific activities related to nanotechnology, commodities and development.

Building on the International Workshop on Nanotechnology, Water and Development (http://www.merid.org/nano/waterworkshop), the Commodities Workshop also helped set the stage for future discussions about specific sectors (e.g., energy and health) and broader issues such as nanotechnology governance. Specifically, the Commodities Workshop contributed to a more robust understanding of the cross-cutting and contextual issues identified in Section 7 of this summary.

Participants identified a range of follow-up actions and activities, which are summarized above in Section 9. These included developing and disseminating more robust general information about nanotechnology, commodities, and development; improving resources to help developing countries and commodity producers identify and anticipate the potential affects of specific nanotechnologies on demand for agricultural, mineral, and other commodities; organizing additional workshops on topics pertinent to nanotechnology and development (e.g., nanotechnology, energy, climate change, and development; technological convergence and development); and exploring and addressing nanotechnology governance, especially those issues of most significance and interest to developing countries. Meridian Institute is taking an active role in pursuing follow-up actions and will periodically check with participants on the progress they are making.

Appendix 1: Workshop on Nanotechnology, Commodities, and Development Agenda

Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks
International Workshop on Nanotechnology, Commodities, and Development
DRAFT AGENDA
29 - 31 May 2007 | Rio de Janeiro, Brazil

BACKGROUND

The term "commodities" often refers to "undifferentiated, widely traded raw materials and agricultural products that are traded principally on the basis of price."[16] Ninety-five of the 141 developing countries derive at least 50 per cent of their export earnings from commodities.[17] In 2003 fifty-four of those countries depended on non-fuel commodities for more than half of their export earnings (e.g., copper and zinc account for 61 per cent of Zambia's export earnings; cotton makes up 72.7 per cent of Mali's earnings).[18] UNCTAD estimates that a total of two billion people—a third of the global population—are employed in commodity production, half of those in agriculture.[19]

Although the use of natural resources and production of commodities may contribute to economic development and enhanced public welfare, many developing countries that are highly dependent on commodity exports as a primary source of revenue appear low on the United Nations Development Programme's Human Development Index. Reliance on revenue from a narrow range of commodities can be risky for countries and producers because international commodities have shown long-term price declines and sharp short-term price fluctuations.

Nanotechnology applications are being developed that could impact global demand for agricultural, mineral, and other non-fuel commodities.[20] Some applications of nanotechnology could increase global demand, while others could lead to a decrease in demand for specific commodities. Applications that result in reductions or increases in the demand for commodities could have potentially far reaching socio-economic and other effects in developed and developing countries.

The dependence of many developing countries on only one or two commodities is likely to accentuate the socio-economic effects resulting from changes in commodity markets in comparison to countries with more diversified economic bases.

Meridian Institute is convening the International Workshop on Nanotechnology, Commodities, and Development to explore the linkages between the development of nanotechnology applications, commodities, and international development. The workshop is part of Meridian's Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks (GDNP). The GDNP is supported by the International Development Research Centre (Canada), UK's Department for International Development, and The Rockefeller Foundation (US). This workshop is co-hosted by the Brazilian Agriculture Research Corporation (EMBRAPA) and the Museum of Life/House of Oswaldo Cruz/Fiocruz.

Given the complexity of the linkages between the development of nanotechnology applications, commodities, and international development, this workshop will focus primarily on agricultural, mineral, and other non-fuel commodities. Meridian Institute plans to convene a separate workshop on nanotechnology, energy, climate change and development, which will include discussion of issues related to energy commodities (e.g., oil and natural gas).

MEETING OBJECTIVES

The International Multi-Stakeholder Workshop on Nanotechnology, Commodities, and Development will:

[1] Examine nanotechnology applications that are effecting or may effect demand for agricultural and mineral commodities;
[2] Identify mechanisms to anticipate, measure, analyze, and address the impact of nanotechnology applications on commodity-dependent developing countries; and
[3] Catalyze actions that could proactively address potential opportunities and risks associated with shifting demand for commodities resulting from nanotechnology research and development.

---

[16] T.F. O'Herron, editor, (1999) "Terms of Trade: the Language of International Trade Policy, Law, and Diplomacy," International Advisory Services Group, Washington, DC.
[17] South Centre, (2005) "Problems and Policy Challenges Faced by Commodity-Dependent Developing Countries (CDDCs)," Geneva, Switzerland.
[18] O. Matringe, (2006) "Commodities at a Glance: Definitions and Importance of Commodities for Developing Countries." INFOCOMM, Commodities Branch, United Nations Conference on Trade and Development (UNCTAD), Geneva, Switzerland.
[19] United Nations Conference on Trade and Development, (2005) "Trends in World Commodity Trade, Enhancing Africa's Competitiveness and Generating Development Gains." Report by the
[20] UNCTAD secretariat for the 2nd Extraordinary Session of the Conference of African Union Ministers of Trade, 21–24 November, 2005, Arusha, Tanzania.
[21] South Centre, (2005) "The Potential Impacts of Nano-Scale Technologies on Commodity Markets: The Implications for Commodity Dependent Developing Countries," Geneva, Switzerland.

AGENDA

29 MAY 2007

18:00 Reception

19:00 Dinner
- Welcome
- Meridian Institute, co-hosts, and financial supporters
- Introductions
- Agenda Review

30 MAY 2007

09:00 Agenda Review – Day 1

Theme 1: Nanotechnology Applications

Sessions in Theme 1 will provide participants an opportunity to share and discuss information about specific nanotechnology applications that may affect demand for agricultural, mineral, and other non-fuel commodities. This information will help establish the context for dialogue about economic, trade, and other issues in subsequent Themes.

09:15 Presentations and Discussion – Nanotechnology Applications Relevant to Demand for Agricultural, Mineral, and Other Non-Fuel Commodities

Presentations and discussion will focus on the following topics.

- Understanding the range of nanotechnology applications relevant to commodities, including convergence of nanotechnology and other technologies (i.e., nanotechnology as part of integrated solutions). Special emphasis will be placed on applications likely to affect demand for agricultural, mineral, and other non-fuel commodities. Presentations will include an overview of existing frameworks for understanding and categorizing nanotechnology applications in terms of their complexity or stage of development.
- In-depth information and discussion about a cross-section of specific nanotechnology applications that are particularly relevant to demand for agricultural, mineral, and other non-fuel commodities.

Background materials that provide information about nanotechnology applications relevant to commodities, especially those that may affect demand for agricultural, mineral, and other non-fuel commodities, will be provided in advance of the meeting.

10:30 Tea and Coffee

11:00 Presentations and Discussion – Nanotechnology Applications (continued)

12:00 Lunch

Theme 2: Commodity Markets and Nanotechnology

Sessions in Theme 2 will allow participants to begin exploring the complex linkages between commodities, development, technology (including nanotechnology), and a range of contextual issues. Discussions will be informed by a background document distributed in advance of the meeting.

13:00 Discussion – Commodities, Development, and Technology

Issues for discussion include, but are not limited to:

- Commodity markets;
- Commodity dependence;
- Technology and commodity dependence;
  - Opportunities and challenges
  - Lessons from history
- Implications of nanotechnology for commodities; and
- Other factors (e.g., intellectual property rights, trade, risks) affecting commodity production and markets.

15:00 Tea and Coffee

Theme 3: Mechanisms for Anticipating and Addressing Fluctuating Demand for Commodities

Building on the preceding discussions, sessions in Theme 3 are designed to identify mechanisms and strategies that help developing countries anticipate and address changes in demand for commodities. Discussions will begin by focusing on assessing the robustness and applicability of existing mechanisms and then shift to identification of gaps and the possible need for new mechanisms. Based on these discussions, participants will identify specific actions and strategies that could help developing countries anticipate and adjust to changes that may result from nanotechnology applications affecting demand for agricultural, mineral, and other non-fuel commodities.

15:30 Discussion – Mechanisms for Adjusting to Changes in Demand for Commodities

Discussions will focus on mechanisms for anticipating and addressing increases and decreases in demand for specific commodities. Participants will discuss both existing mechanisms and new mechanisms that may be needed with the emergence of nanotechnology.

Background material about existing mechanisms will be provided in advance of the meeting.

16:15 Small Group Discussion – Strategies and Actions to Address Nanotechnology's Effects on Commodities and Production

Helping developing countries prepare for potential increases or decreases in demand for commodities, which are linked to nanotechnology applications, will require monitoring, analysis, forecasting, and research to understand the impacts of nanotechnology on specific commodities and production processes.

Participants will break into small groups and discuss specific monitoring, analysis, forecasting, research, policy development, and other needs and identify actions, strategies, and mechanisms that might be needed to address these needs. Participants will specify whether the actions, strategies, and mechanisms identified are applicable at the local, national, regional, and/or international levels. Possible issues for discussion include:

- Trade mechanisms, agreements, and regimes;
- Research programs;
- Education and training programs;
- Product development initiatives;
- Monitoring and forecasting (i.e., early listening and early warning systems);
- International collaboration; and
- Public engagement and dialogue.

18:30 Reception and Hosted Dinner

31 MAY

08:30 Small Group Discussions – Strategies and Actions (continued)

10:00 Reports and Discussion – Actions, Strategies, and Mechanisms to Address Nanotechnology's Effects on Commodities

Breakout groups report back to the plenary and participants discuss the specific monitoring, analysis, forecasting, research, policy development, and other needs and actions, strategies, and mechanisms that might be used to address these needs.

10:30 Tea and Coffee

Theme 4: A Framework for Action and Next Steps

Sessions in Theme 4 are aimed at consolidating and refining the actions and strategies identified during the small group discussions into a framework for action that could proactively address potential opportunities and risks associated with shifting demand for agricultural, mineral, and other non-fuel commodities resulting from nanotechnology research and development.

11:00 Discussion – A Framework for Action

Based on the breakout group reports, participants will begin to develop a framework of strategies, interventions, and other actions that address the potential effects nanotechnology might have on demand for commodities. The framework could address issues such as:

- What are the priority issues that need to be addressed?
- What existing resources and systems are already available to help countries address these issues?
- What additional strategies, interventions, and actions are needed?
- Who is best positioned to pursue these actions at local, national, regional, and international levels?

Participants will be asked whether proposed actions are broadly applicable across sectors or specific to individual sectors and whether they are applicable at the local, national, regional and/or international levels.

12:30 Lunch

14:00 Discussion – Next Steps

Participants will review the framework and discuss steps they and the GDNP can take to ensure that the appropriate individuals and institutions are briefed about and engaged in pursuing the strategies identified during the meeting.

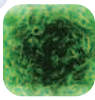
15:30 Tea and Coffee

16:00 Closing Plenary

17:00 Adjourn







Appendix 2: Workshop on Nanotechnology, Commodities, and Development Participant List

Tara Acharya
Associate Director
The Rockefeller Foundation
420 Fifth Avenue
New York, NY 10018 - United States
phone number: 1-212-869-8500
fax number: 1-212-764-3468
e-mail: tacharya@rockfound.org

Carlos Aguirre
Professor
Institute for Social and Economic Research
Catholic University of Bolivia
Ave 14 de Septiembre 4850, Obrajes
PO Box 4805
La Paz- Bolivia
phone number: 591-2-278-2222
fax number: 591-2-278-6749
e-mail: caguirre@ucb.edu.bo, csaguirreb@gmail.com

Aftab Ahmad
Senior Science and Technology Policy Advisor
Office of the Chief Scientist
Natural Resources Canada
20D4-2, 580 Booth Street
Ottawa, Ontario K1A 0E4 - Canada
phone number: 1-613-992-0256
fax number: 1-613-947-1426
e-mail: aahmad@nrcan.gc.ca

Carlos Amorin
Communications Advisor
Latin American Secretariat of
The International Union of Food and Agriculture Workers
Wilson Ferreira Aldunate 1229/201
Montevideo – Uruguay
phone number: 598-2-9007-473/902-1048
e-mail: uita@rel-uita.org

Samuel Asfaha
Programme Officer, Commodities and Economic Diversification
South Centre
Ch. Champ d'Anier 17
Case Postale 228
1211 Geneva 19
Switzerland
phone number: 41-22-791-8050
fax number: 41-22-798-8531
e-mail: asfaha@southcentre.org

Peter Cookson
Business Manager / Senior Research Fellow
Centre for Material and Fibre Innovation
Deakin University
Geelong Technology Precinct
Geelong Victoria 3217 - Australia
phone number: 61-3-5227-3243
fax number: 61-3-5227-1103
e-mail: peter.cookson@deakin.edu.au

Sonia Dalcomuni
Director, Center for Economics and Law Studies
Federal University of Espirito Santo
Campus Universitário Alaor Queiroz de Araújo
Av. Fernando Ferrari, S/N° - Goiabeiras
Victória/ES - CEP 29060-900 – Brazil
phone number: 55-27-3335-2580
e-mail: sonianano@terra.com.br

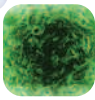
Elenita Dano
Associate
Third World Network
N. Torres cor. Del Pilar Streets
Door 4 Arlene Apartments, Barrio Obrero
Davao City, 8000 - Philippines
phone number: 63-82-305-3658
fax number: 63-82-305-3658
e-mail: nethdano@pacific.net.ph

Joydeep Dutta
Director, Center of Excellence in Nanotechnology
Asian Institute of Technology
PO Box 4
Klong Luang
Pathumthani 1210 – Thailand
phone number: 66-2-524-5680
fax number: 66-2-524-5697
e-mail: joy@ait.ac.th

José Geraldo Eugenio de França
Executive Director
Brazilian Agricultural Research Corporation (Embrapa)
Parque Estação Biológica – Pq EB s/n
Av. W3 Norte (final) - CEP 70770-901
Brasilia, DF - Brazil
phone number: 55-61-3448-4433
fax number: 55-61-3347-1041
e-mail: geugenio@sede.embrapa.br







Joseph Gogo
Former Director
Science and Technology Policy Research Institute
PO Box CT 519, Cantonments
Accra - Ghana
phone number: 233-24-435-5179
fax number: 233-21-773-068
e-mail: jgogo@email.com

Mamadou Goïta
Executive Director
IRPAD/Afrique
BP: 2729 Bamako - Mali
phone number: 223-223-89-20
fax number: 223-223-89-21
e-mail: mamadou_goita@yahoo.fr

Anandajit Goswami
Research Associate
Centre for Global Agreements, Legislations and Trade Resouces and Global Security Division
The Energy and Resources Institute
Darbari Seth Block, IHC Complex
Lodhi Road, New Delhi 110 003 - India
phone number: 91-11-2468-2100
fax number: 91-2468-2144
e-mail: anandjit@teri.res.in

Guillaume Gruere
Research Fellow
Environmental and Production Technology Division
International Food Policy Research Institute
2033 K Street NW
Washington, DC 20006 - United States
phone number: +1 202-862-8156
e-mail: g.gruere@cgiar.org

Maria José Guazzelli
Agronomist
Centro Ecológico Ipê-Serra
Rua Luiz Augusto Branco
725 - Bairro Cruzeiro
Ipê, RS - CEP 95240-000 – Brazil
phone number: 55-48-323-76-468
e-mail: mariajose.guazzelli@gmail.com

Thembela Hillie
Principal Research Scientist
National Centre for Nanostructured Materials
Council for Science and Industrial Research
PO Box 395
Pretoria, 0001 ZA - South Africa
phone number: 27-12-841-3874
fax number: 27-12-841-2865
e-mail: thillie@csir.co.za

Richard Isnor
Director, Innovation, Policy and Science
International Development Research Centre
250 Albert Street
Ottawa, ON K1P 6M1 – Canada
phone number: 1-613-236-6163, ext. 2004
fax number: 1-613-567-7749
e-mail: risnor@idrc.ca

José Fernando Thomé Jucá
Director
Northeast Center for Strategic Technologies (CETENE)
Av. Prof. Luís Freire, 1
Cidade Universitária
Recife, PE - CEP: 50740-540 - Brazil
phone number: 55-81-3271-2307
fax number: 55-81-3271-9815
e-mail: jucah@ufpe.br

Juana Kuramoto
Associate Reseracher
Group for the Analyis of Development
Av. del Ejercito 1870
San Isidro
Lima 27 – Peru
phone number: 511-264-1780
fax number: 511-264-1882
e-mail: kuramoto@grade.org.pe

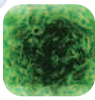
Michelle Londa
Research Professor
Texas State University
601 University Drive
Centennial Hall 340 C
San Marcos, TX 78666 - United States
phone number: 1- 512-245-8359
e-mail: ml40@txstate.edu

Alvaro Macedo da Silva
Director, Embrapa Agricultural Instrumentation
Brazilian Agricultural Research Corporation (Embrapa)
Rua XV de Novembro, 1452, Centro
CEP 13560-970
São Carlos, SP - Brazil
phone number: 55-16-3374-2477
fax number: 55-16-3372-5958
e-mail: chgeral@cnpdia.embrapa.br

Paulo Roberto Martins
Researcher
IPT Agency of Innovation
Avenida Prof. Almeida Prado, 532
Cidade Universitária
Butantã, SP - 05508-901 - Brazil
phone number: 55-11-3767-4658
fax number: 55-11-3768-2045
e-mail: marpaulo@ipt.br







Pat Mooney
Executive Director
Action Group on Erosion, Technology and Concentration
ETC Group
431 Gilmour Street, 2nd Floor
Ottawa, ON K2P 0R5 - Canada
phone number: 1-613-241-2267
fax number: 1-613-241-2506
e-mail: mooney@etcgroup.org

Cauê Ribeiro de Oliveira
Researcher, Embrapa Agricultural Instrumentation
Brazilian Agricultural Research Corporation (Embrapa)
Rua XV de Novembro, 1452
CEP 13560-970 - São Carlos, SP - Brazil
phone number: 55-16-3374-2477
fax number: 55-16-3372-5958
email: caue@cnpdia.embrapa.br

Peter O'Neill
Deputy Head
Central Research Department
Department for International Development
1 Palace Street
London, SW1E 5HE - United Kingdom
phone number: 44-20-7023-0430
e-mail: p-oneill@dfid.gov.uk

Françoise Roure
Senior National Adviser
Ministry of Economy, Trade and Industry
Batiment Necker, Teledoc 792
120, rue de Bercy
75572 Paris Cedex 12 - France
phone number : 33-1-53-18-56-87
fax number : 33-1-53-18-57-03
e-mail: francoise.roure@industrie.gouv.fr

Leonela Santana-Boado
Economic Affairs Officer
Division on Trade in Goods and Services, and Commodities
United Nations Conference on Trade and Development,
Commodities Branch
Palais des Nations
8-14, Av. de la Paix
1211 Geneva 10 – Switzerland
phone number: 41-22-917-5702
fax number: 41-022-917-0509
e-mail: leonela.santana-boado@unctad.org

Jorge Tello Coello
Coordinator
Andean Rural Development and Agricultural
Competitiveness Program | Andean Community
Paseo de la Republica 3895
San Isidro, Lima 27 – Peru
phone number: 511-411-14-00
fax number: 511-221-33-29
e-mail: jtello@comunidadandina.org

Jean Woo
Program Officer, Innovation, Technology and Society
International Development Research Centre
250 Albert Street
Ottawa, ON K1P 6M1 - Canada
phone number: 1-613-236-6163
fax number: 1-613-567-7749
e-mail: jwoo@idrc.ca

Meridian Institute

Michael Lesnick
Senior Partner
Meridian Institute
863 Rodney Drive
Nashville, TN 37205 - United States
phone number: 1-615-353-0854
fax number: 1-615-469-1065
e-mail: mlesnick@merid.org

Todd Barker
Partner
Meridian Institute
29 Tarbox Road
Jericho, VT 05465 - United States
phone number: 1-802-899-2625
e-mail: tbarker@merid.org

Rex Raimond
Mediator
Meridian Institute
PO Box 1829
Dillon, CO 80435 – United States
phone number: 1-970-513-8340, ext. 230
fax number: 1-970-513-8348
e-mail: rraimond@merid.org

Leili Fatehi
Research Associate
Meridian Institute
1920 L Street NW, Suite 500
Washington, DC 20036 – United States
phone number: 1-202-354-6455
fax number: 1-202-354-6441
e-mail: lfatehi@merid.org

Ana Coelho
Project Coordinator
Meridian Institute
1920 L Street NW, Suite 500
Washington, DC 20036 – United States
phone number: 1-202-354-6447
fax number: 1-202-354-6441
e-mail: acoelho@merid.org

Appendix 3: Working definitions of Cross-Cutting Issues

Meridian Institute developed the following definitions to clarify the distinguishing characteristics of these cross-cutting issues, while recognizing that there is some overlap and important connectivity between them.

Product Research and Development – Systematic activities to increase knowledge and apply it to the (further) development of new applications. In the context of the workshop, participants focused on assessing the maturity of specific nanotechnology applications and the steps that would be necessary for further development.

Environmental, Human Health, and Safety Risks – Potential harm that may arise from a material, combined with probability of an event (e.g., exposure). In the context of this document, the focus is on potential risks to the environment, human health or worker safety.

Socio-Economic Issues – Impacts on individuals, institutions, or society resulting from a policy or project (e.g., the introduction of a product, of a market intervention) such as price changes, welfare changes, and employment changes.

Ethics – A branch of philosophy concerned with evaluating human action, in particular what is considered right or wrong based on reason. In the context of nanotechnology, ethical questions have focused, for instance, on applications related to human enhancement and performance, privacy questions resulting from research into nanotechnology monitoring systems, and questions about possible malevolent or military uses of nanotechnologies.

Intellectual Property Rights and Access – Intellectual property rights (IPRs) are legal protections for intellectual property claimed by individuals or institutions. Copyrights, patents and trademarks are common mechanisms for protecting intellectual property. IPRs are intended to spur innovation and commercialization, but may limit the ability of individuals and institutions to access technology.

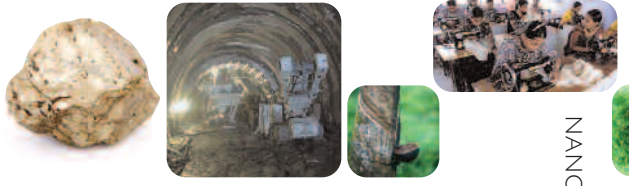
Public Participation and Engagement – Processes that affect whether and how individuals participate in societal discourse, including public information, public education, and public discussion and dialogue regarding nanotechnology.

Governance – Processes, conventions, and institutions that determine how power is exercised to manage resources and societal interests, how important decisions are made and conflicts resolved, how interactions among and between the key actors in society are organized and structured, and how resources, skills and capabilities are developed and mobilized for reaching desired outcomes. This includes risk governance (i.e., comprehensive assessment and management strategies to cope with risk) and governance for innovation (i.e., programs targeting nanotechnology R&D for public objectives). Using this definition, governments, governmental and intergovernmental institutions, as well as public and private corporations, non-governmental organizations, and informal associations are examples of institutions involved in governance.

Capacity Building – Assistance provided to develop a certain skill or competence, including policy and legal assistance, institutional development, human resources development, and strengthening of managerial systems.

International Collaboration and Cooperation – Collaborative partnerships between individuals, and institutions from developed and developing countries at a local, national, regional level on any aspect of nanotechnology, including North-South (i.e., developed and developing) and South-South (i.e., developing – developing)

Scalability, Delivery, and Sustainability – The ability to scale-up production and distribution of products so they reach large numbers of people (i.e., success not limited to pilot projects) and the sustainability of products, which relate to numerous factors including, for example, costs, ease of use, and durability.



Appendix 4: Overview Document – Nanotechnology, Commodities and Development

Nanotechnology, Commodities, and Development

Many developing countries depend heavily on commodities for export earnings and as a primary source of employment and income for their citizens. Nanotechnology applications are being developed that could impact global markets for agricultural, mineral, and other non-fuel commodities. These applications could, in some instances, reduce demand for some commodities and, in other instances, create new or wider markets for commodities. These changes could have potentially far reaching socio-economic and other implications, both positive and negative, for developing countries.

Ninety-five out of the 141 developing countries derive at least 50 percent of their export earnings from commodities. Many commodity-dependent developing countries (CDDCs) also appear low on the United Nations Development Programme's Human Development Index. Furthermore, UNCTAD estimates that a total of 2 billion people – a third of the global population – are employed in commodity production, with half in agriculture. Awareness and understanding of the potential implications of nanotechnology for commodity-dependent developing countries (CDDCs), and developing countries in general, is of paramount importance to ensuring that the opportunities of nanotechnology for these countries are maximized, while its risks are minimized.

This document is intended to raise awareness and inform decision-makers from all sectors of society at the international, regional, national, and local levels. It describes a set of key issues that should be considered when evaluating the potential implications of nanotechnology for a developing country or commodity sector. Additional resources are listed on the last page of this document.*

What is Nanotechnology?

Perceived by many as the next "transformative technology," like electricity or the Internet, nanotechnology encompasses a broad range of tools, techniques, and applications that manipulate or incorporate materials at the nanoscale (a nanometer is one billionth of a meter) in order to yield novel properties that do not exist at larger scales.

These novel properties may enable new or improved materials, products, and processes that are more efficient, effective, and inexpensive than those currently available. For example, nanomaterials are being developed that provide greater strength, durability, and flexibility than steel, but are also lighter-weight and less expensive to produce. Additionally, nanotechnology may significantly increase production capacity by enabling manufacturing processes that create less pollution and have modest capital, land, labor, energy, and material requirements. Nanotechnology applications for agriculture, mining, minerals, fibers and textiles are already on the market and many more will be available in the next few years.

Both the public and private sectors in developed and developing countries are investing heavily in nanotechnology research and development. More than 20 countries, including middle-income developing countries such as China, South Africa, Brazil, and India, currently have national nanotechnology programs, and many more are developing or expanding nanotechnology research and development capacity. The collective public and private sector investment in 2005 was approximately USD10 billion, up 10% from 2004. Additionally, patents on nanotechnology-related inventions, scientific literature citations, and nanotechnology-based products reaching the market are skyrocketing globally.

Nanotechnology, Commodities, and Developing Countries: Opportunities and Risks

Nanotechnology has been identified as a promising area of technological advancement for CDDCs, and developing countries in general, because it may enable more efficient, effective, and inexpensive materials, products, and processes, including manufacturing processes that have modest capital, land, labor, energy, and material requirements. Nanotechnology may also create new or wider markets for commodities produced by developing countries and opportunities to produce value-added commodity products.

Concerns have also been raised that the same characteristics that make nanotechnology promising for developing countries also create the possibility that it may displace commodities, labor, and industries and worsen the overall position of developing countries. Some organizations have also expressed concerns that nanoscale

* Acknowledgements: This document is informed by the participants and discussions in Meridian Institute's International Workshop on Nanotechnology, Commodities, and Development (Commodities Workshop), which was held in Rio de Janeiro, Brazil on 29-31 May 2007 to explore the linkages between the development of nanotechnology applications, commodities, and international development (www.merid.org/nano/commoditiesworkshop). The Commodities Workshop is part of Meridian's on-going Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks (www.merid.org/showproject.php?ProjectID=9233.4).

materials could pose unknown risks, including risks to human health and the environment, which might be particularly difficult to identify and manage.

The following tables provide examples of nanotechnology applications and possible implications for commodities. The net effects of nanotechnology on supply and demand markets for commodities are difficult to predict and will likely vary for different commodities, technologies, and countries.

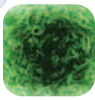
Examples of Nanotechnology Applications and Possible Implications for Commodities

Applications of Nanotechnology for Agriculture	
Applications	**Potential Implications**
Nano-based food additives	Value Addition
Nanosensors; nano-pesticides and fertilizers; nano-based smart delivery systems	Improved Productivity
Biofuels and biodegradable plastics	New Markets as Feedstocks
Nano-based packaging	Improved Product Quality
Functional foods; nutraceuticals	New Industrial and Commercial Markets
Functional food substitutes	Reduced Demand
Nanotechnologies for development of new acreage	Increased Supply
Nanoparticles for biomedical diagnostics, treatments, and coatings.	New Industrial and Commercial Markets
Nanoscale metal oxides for personal care products, water treatment, and energy production	New Industrial and Commercial Markets
Substitute materials such as carbon nanotubes and quantum dots.	Reduced Demand

Applications of Nanotechnology for Metal and Mining Sectors	
Applications	**Potential Implications**
Silver, titanium, and other metal nanoparticle coatings for antimicrobial properties.	Value Addition
Phytomining and microbial methods of metal nanoparticle production.	Improved Productivity; Increased Supply
Nanocatalysts for emissions control systems, environmental remediation, fuel cells, chemical processing; and petroleum production.	New Industrial and Commercial Markets
Nanoparticles for circuitry, semiconductors, optics, electronics, sensors, and other electronic devices.	New Industrial and Commercial Markets







Applications of Nanotechnology for Fiber, Textiles, and Apparel	
Applications	**Potential Implications**
Nanocoatings and treatments for performance fabrics.	Value Addition
Nanotechnology-based improvements for sewing machines and other production equipment.	Improved Productivity
Nanofibers for environmental remediation filters.	New Industrial and Commercial Markets
Thermally and electrically conductive fibres and textiles.	New Industrial and Commercial Markets
Synthetic fiber and textile substitutes.	Reduced Demand

Applications of Nanotechnology for Rubber, Plastic, and Composite Materials	
Applications	**Potential Implications**
Nano-additives and fillers for materials with improved vulcanization and physical, thermal, and electrical properties.	Value Addition
Nano-enhanced materials with novel thermal, magnetic, or electircal properties for use in electronics, environmental remediation, and other industries.	New Industrial and Commercial Markets
Nano-based biodegradable plastics.	New Industrial and Commercial Markets
Nanoclays, aero-gels, and engineered nanocomposite substitute materials.	Reduced Demand
Improved life of nano-enhanced materials.	Reduced Demand

Key Questions and Issues for Consideration

A number of cross-cutting issues and questions should be considered in evaluating and making more informed decisions about the potential implications of nanotechnology applications for specific economies and commodity sectors. While these issues may be generally applicable to technologies, the unique characteristics of nanotechnology may result in different considerations for each cross-cutting issue, which, in turn, could require new and different strategies for addressing these issues. These issues and questions include, but are not necessarily limited to:

- Product research and development
  - What is the technology's stage of development (e.g., on the market, field tested, lab tested, or in early research stages)?
  - What will it take for the technology to move from the lab to the market?
  - Does the technology support commodity-based industries? Which industries?
  - Is the research and development aimed at meeting development needs?
  - What incentives, if any, should be provided to encourage responsible research and development, as well as adoption and adaptation, of new technologies?
- Environmental, human health, and safety (EHS) risks
  - What are the technology's potential EHS risks?
  - How extensively have the EHS risks been evaluated and how can EHS information be accessed?
  - What is the need for EHS risk studies and development of risk management approaches?
- Socio-economic issues
  - What are the country's national development needs and strategies and how can the technology play a role?
  - Will the technology function as a complement or substitute for existing commodities?
  - How equipped are commodity producers and markets to predict and adjust to market changes precipitated by technology?

  - How, if at all, will the technology affect the socio-economic position of workers and (poor) communities involved in the production, trade, or consumption of commodities?

- Ethics
  - Will the benefits and/or risks disproportionately effect a segment of the population?
  - Are the potential human enhancement, privacy, and other ethical implications of the technology?

- Intellectual property rights and access
  - What are the potential impacts of patents (e.g., scope, type (product or process), ownership, management) on the ability of developing countries to access or develop new technologies and to benefit from them economically?
  - What are the potential effects of the technology and its patents on the consolidation of multinational companies and their levels of horizontal and vertical integration?
  - With whom and to what degree is ownership of the technology concentrated and how will that affect the ability for commodity producers and commodity producing countries to benefit from the technology?

- Public participation and engagement
  - Who should be involved in discussions on nanotechnology?
  - What information is needed for an informed public dialogue?
  - How can access to information about the technology and its potential implications be maximized?
  - What are the infrastructure and human capacity challenges to public participation and engagement?

- Governance
  - What are the roles of key stakeholders (e.g., government, industry, NGO, academia, etc.) in nanotechnology governance?
  - Should nanotechnology applications be regulated and, if so, by whom?
  - How and by whom should research efforts be guided to meet national sustainable and human development needs and goals?
  - Who should fund and conduct nanotechnology risk assessments?
  - How and by whom should the opportunities and risks be communicated to industry, workers, and the public?
  - What mechanisms (e.g., monitoring, forecasting, research, policy development, and other strategies) exist or are needed to help developing countries and commodity producers anticipate and adjust to changes that may result from technology-induced changes in demand for commodities?

- Capacity building
  - What are the needs and potential strategies for ensuring that developing countries have the educated and trained workforce and access to information to evaluate technologies and select the best available option(s) to meet their near- and long-term needs?
  - What are the appropriate roles of communities, governments, researchers, companies, and other groups in capacity building processes?

- International collaboration and cooperation
  - How can international collaborations and cooperation best be used to enhance research and development, capacity building, and other issues?

- Scalability, delivery, and sustainability
  - How can scale-up, distribution, and business sustainability be ensured so products reach the people that need them?
  - How can the public and private sector work together to distribute and facilitate use of the technology?

Background Materials

The following background materials are available online at http://www.merid.org/nano/commoditiesworkshop/backgroundmaterials.php:

Nanotechnology, Commodities, and Development – This paper, developed by Meridian Institute, provides a brief introduction to issues at the intersection of commodity dependence, development and technology; general information regarding the opportunities and challenges nanotechnology offers for developing countries and, in particular, commodity-dependent developing countries; descriptions of commodity markets that are important to many developing countries (e.g., agriculture, mining and minerals, textiles, and rubber and composites); an overview of nanotechnology applications relevant to those sectors; and, specific examples of relevant nanotechnology applications.

Commodities, Development, and Technology – Developed by Meridian Institute as a supplement to "Nanotechnology, Commodities, and Development," this paper provides an overview of commodity markets, commodity dependence and poverty; the history, trends, and key issues in global commodity markets and how these issues affect commodity-dependent developing countries; and key issues at the intersection of commodity dependence, development, and technology.

Nanotechnology and Commodities Database – An online database developed by Meridian Institute to catalog specific examples of nanotechnology applications relevant to agricultural, mining and mineral, fiber and textile, rubber and composite, and other commodities.

Overview of the Situation of Commodities in Developing Countries – Written by the Common Fund for Commodities, this paper provides information on the problems faced by commodity producers in developing countries.

The Potential Impacts of Nano-Scale Technologies on Commodity Markets: The Implications for Commodity Dependent Developing Countries – Written by the ETC Group for the South Centre, this paper provides a brief introduction to nanoscale technologies and examines their potential impacts on commodity dependent developing countries.

Additional Resources

International Workshop on Nanotechnology, Commodities, and Development

Provides more information on the Commodities Workshop, including access to the meeting agenda, participant list, background materials, and presentations.
http://www.merid.org/nano/commoditiesworkshop/

Meridian Institute Nanotechnology Portal

Provides additional information on Meridian Institute's nanotechnology-related projects and activities.
http://www.merid.org/nano/

Nanotechnology and Development News

Meridian Institute's Nanotechnology and Development News (NDN) is a free, daily electronic news service covering the most important global developments at the nexus of nanotechnology, poverty alleviation, and the role of science and technology in development. NDN draws information from a diverse range of sources on scientific innovations and technological applications; policy issues; risk-related information; intellectual property rights and access to data; technology transfer and capacity building; global and regional networks; and economic development.
http://www.merid.org/NDN/