

Editorial

Green Chemistry and Sustainable Development

In January, 2007 a Workshop on Green Chemistry was held in Johannesburg. John Warner and Amy Cannon (University of Massachusetts, Lowell) were the "guiding spirits" for this effort, while funding came from the South African Paper and Pulp Industry (SAPPI). At this meeting Professor Paul Ndalut from Daniel Arap Moi University wisely observed (I paraphrase): "Green Chemistry is a good idea. But Africa has many burdens, including poverty, war and the epidemics of HIV, malaria and tuberculosis. Green Chemistry is a priority only if it helps address these issues." I propose that the strongest justification for Green Chemistry in Africa is precisely the opportunity to address the differences between rich and poor in access to technology and creating sustainable economic development. Green Chemistry is closely linked to the United Nations' Millenium Development Goals 6 – 8 <http://unstats.un.org/unsd/default.htm>, which are:

- Combat HIV/AIDS, malaria and other diseases
- Ensure Environmental Sustainability
- Develop a global partnership for development

Today's civilization is not sustainable for future generations. Broad, global access to the fruits of technology and acceptable standards of development is also inequitable. The WHO's 2005 Millenium progress report, for example, estimates that the richest 15% of the world's population consumes 91% of medicines (cf. above URL). China and India have made enormous strides in transitioning towards "first-world" economies. This has been accomplished, however, at huge costs to

respective national health and safety and with global environmental impacts. A good deal of the production capacity that drives economic development in India and China results from the moving the manufacturing of goods to lower cost centers of production. Thus, production for export drives a substantial amount of economic development. This practice must be coupled with the best exercise of green technologies, however, to prevent emerging economies from becoming the dumping ground for global waste.

The requirements that we make of Green Chemistry are to enable substantial progress towards equitable standards of living in a manner that is sustainable for future generations. Playing such a game of "catch up" is arduous and (evidenced by China/India) risky. Some exciting examples of green, sustainable activity are being generated within Africa. I largely restrict my remaining comments on Green Chemical production to the area of making medicines. One example which fits the label of "green" is the medication NICOSAN™. This treatment is a herbal therapy for sickle cell anemia that is an excellent example of the use of knowledge indigenous to Africa. "Discovered" by the National Institute of Pharmaceutical R&D in Abuja, Nigeria (NIPRD) and marketed by Xechem International, this mixture of 7 major active ingredients, isolated by aqueous-based extraction from 4 plant sources, is controlled within acceptable limits for each major constituent and total active content by HPLC. While not a cure, clinical trials indicate that the large majority of patients (73 – 90%) taking NICOSAN no longer experience sickle cell

“crises” while on treatment. This is an absolutely first-rate example of partnership for development because the initiation and ownership of nearly all important activities and outcomes of this project is within Africa. Only a few of the many other efforts going on in Africa are represented by LaGray Chemicals in Ghana, Sigma Tau of Ethiopia, Advanced BioExtracts in Kenya, Arvir of South Africa and Cipla’s emerging drug production in Uganda. Each of these efforts represents a step in making the production of medicines sustainable within Africa.

One sticking point for development is money. Much of the capital investment needed for wholesale advancement in standards of living is under the control of high-income countries. Although a number of very large donor efforts provide essential medicines for Africa, nearly all of this money is spent **outside** of the continent. Although these efforts improve access to essential medicines, the catalysis of sustainable development in Africa is not a direct goal of such efforts. An opportunity for obtaining investment for sustainability, however, lies within the objectives of huge foundations such as the Gates Fund and the Skoll Foundation. One way of engaging the interests of these groups is through the exercise of advanced technologies.

Within “Big Pharma” it is estimated that 36% of all industry expense is devoted to manufacturing (from the April 30, 2003 API Workshop on *“Influencing Change in the Regulatory Environment,”* Dorado, Puerto Rico). As a figure for comparison, the contribution of R&D to overall industry expense is a much lower figure, at roughly 16%. The investments required by Innovator companies to implement new technologies (several hundred million USD) for manufacturing are truly staggering. The prudent, intelligent exercise of advanced manufacturing technologies within Africa represents an opportunity for emerging nations to initiate sustainable, regional production and potentially create markets for export. Africa has an advantage over global industries in this regard by virtue of the ability to implement truly novel technologies without

abandoning existing investments in outmoded or less than optimal manufacturing facilities, and by lower fixed costs in human capital and construction. The elements of achieving sustainable regional production include:

- Coupling indigenous knowledge with good clinical and manufacturing practices
- Identifying technologies that are elegant by virtue of their simplicity
- Designing a “Green footprint” for advanced technology manufacturing
- Utilizing process analytical technologies (cf. NICOSAN) in a manner that guarantees Quality in addition to rugged, robust manufacturing.

Let us suppose that these broad objectives are demonstrated for the production of essential medicines, and with the prudent use of financial resources. Under these circumstances one would expect that the interest of the International donor agencies and investment communities would take a great interest in funding the full-scale commercial startup of such enterprise. A fuller discussion of such ideas is truly beyond the space available for my comments. I welcome your thoughts, and I thank you for the opportunity to express my opinions.

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