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lack of access to computers in Africa is resulting in a failure to develop computer skills. Certainly, training in the use of ICTs is a must for every chemist on the African continent. "Public domain knowledge and technology for chemical processes are available through information and communication technology for the exploitation and development of Africa's resources. More training is needed in tapping and utilizing such knowledge and technology."

Market Forces

Prof. Wandiga informed the group that, although the total population of Kenya, Uganda, and Tanzania, is near 75 million, the per capita income is only \$200–300. The buying power of African citizens is currently too small to sustain a dedicated domestic chemical industry. A second strong force arises from the current economic situation that compels African nations to export their resources as raw materials. Compounding these forces are weak marketing networks for African products. Under the circumstances, which include falling commodity prices, inflation of local currency, and few markets for African products, chemical research is not an economically important activity. As long as these current forces are dominant, Africa will not develop a chemical industry. Prof. Wandiga observed, "As a start, African countries must break the barriers that exist between states on the continent. Africa further needs to discard the concept that Africans cannot process their own raw material for competitive global trade. Lastly, Africa must redouble its efforts to train its youth to market African products and to use the latest ICT technology."

Enabling Policies

Dr. Wandiga noted that the African policy-making community and national leaders must understand that they need the discipline of chemistry if they are to succeed as rulers. Moreover, African nations, as in all

nations, need to promote the basic principles of quality of life, democracy, and the dignity of and respect for human life. Only through such policies can the majority of citizens excel by applying their intellect, knowledge, and technological skills.

"There must be a high-priority policy to develop and enable the chemical industry. Without direct government support for industry, little can be achieved." Dr. Wandiga recommended that "governments set up priority projects for development of chemical research capability, with concomitant incentives for industrial development. These new progressive policies can only emerge if Africans at both local and international levels accept the principle that it is essential for Africa to trade in finished products. Africa must also implore its brothers in developed countries to stop looking at Africa as a supplier of unfinished, unprocessed raw materials for their industry."

General Public Support

Prof. Wandiga expressed the opinion that the African public is very supportive of the chemical industry, provided the industry continues to supply consumer goods and provide jobs. As public awareness increases, it is essential that industry does not negate the public perceptions through use of "non-green" chemistry processes. Given the high unemployment rate on the continent, the industry will find ready support if it promotes quality of life through employment and responsible care for its products. Prof. Wandia concluded, "Ethical considerations by the industry need to play a leading role in its promotion. At all times one should remember that the African continent is ecologically fragile. Preservation of the environment for future generations is part and parcel of the promotion of the chemical industry on the continent. For the industry to continue to enjoy public support, it must regulate itself and it must take the lead in conservation matters."

Liaison Between IUPAC and AAPAC

Prof. Bekoe opened the discussion of the liaison between AAPAC and IUPAC by noting that the objec-

tives of the two organizations are complementary. The partnership could work to strengthen African chemical societies, and also to advocate industrial development in Africa. There is, he said, a clear need to work toward a form of affiliation between the two organizations. AAPAC has many bright members but it is young and weak in resources. IUPAC assistance to AAPAC through the IUPAC web site would help greatly by sharing information with and among African scientists.

Prof. Jortner added that the AAPAC/IUPAC liaison should be both regional and global. Elements of co-operation could include dissemination of industrial and environmental information, joint planning, catalysis of programs for Africa, including electronic communications, and assistance in interactions with governments

Concluding Remarks, Plans, and Proposals for Future Actions

Dr. Abegaz offered plans and proposals for future actions as follows:

- Chemists should pledge partnership to each other. Country-specific or regional problems should always be addressed with quality and relevance.
- A census should be taken of professional resources in Africa. AAPAC should prepare directories of African scientists and of papers published.
- Problems in obtaining access to chemical information need to be solved. The Internet gives access to information, but well-stocked libraries provide ownership of the information.
- Creative approaches can make scarce instrument resources generally available to African scientists. As an example, NAPRECA can now utilize its FTNMR instrumentation more effectively by sending Free Induction Decay (FID) data directly by e-mail to users for analysis. This use of e-mail allows researchers quicker access to spectra and saves analysis time in the primary instrument facility.
- African institutions need to obtain fairer prices when purchasing instrumentation. Vendors normally charge more in Africa than in developed countries.

In his concluding remarks, Prof. Jortner noted that this meeting between AAPAC and IUPAC officials has inspired deep respect for the chemistry community in Africa as it faces difficult problems, even as AAPAC adopts firm commitments and a sense of purpose for the future. He provided the following summary of the central issues, together with several proposals and conclusions.

1) *Human capital development.* Plans must be made for human capital development in Africa with the understanding of chemistry as the conceptual founda-

tion of materials science, physics, and biology. Goals, objectives, and programs for education on all levels require long-term strategic plans.

2) *Research at the graduate level.* Research in the African university system is essential. The professional development of young scientists, graduate students, post-docs, and beginning faculty members must be a top priority. To help in this area, IUPAC will bring 20 young chemists from developing countries to the Berlin Congress in 1999.

3) *Reduction of braindrain.* While scientists should be free to move wherever their interests take them, IUPAC and AAPAC must strongly recommend that the research systems of Africa take initiatives to bring back young, outstanding scientists after their training abroad. Special programs should be instituted to do this, for example a program of research grants of \$20,000–40,000 over a period of 4–5 years for young scientists who return to Africa. Additional programs should be implemented to foster exchange of personnel in both directions.

4) *Worldwide responsibility.* It is the moral responsibility of the worldwide chemistry community to join forces to help Africa in building its education and research capabilities at all levels.

5) *Bridging the gap between donors and developing countries.* IUPAC might act as an independent, authoritative, nongovernmental, politically neutral body to help with management and accountability in the distribution of research funds in Africa. The Union also could contribute its expertise to assist with external review of research proposals.

6) *Regional and international collaboration.* Support must be found for regional cooperation. Intra-African collaboration is often more limited in scope than is collaboration with countries outside Africa, because most financial support for collaboration originates outside the African continent. Development of an electronic *African Journal of Chemistry* would increase collaboration in Africa and develop worldwide recognition for the chemical sciences on the African continent.

7) *Problems and challenges of the chemical industry in Africa.* While it is important to curb pollution, upgrade industrial technology, and facilitate regional and industry–university cooperation, it is also necessary to develop a “green” chemical industry. Environmentally and economically viable industries must be attracted to Africa.

8) *Environmental chemistry.* Issues of chemistry and the environment were raised in the conference pertaining to pollution, food, water, and health problems. Environmentally benign chemistry solutions will be sought.

9) *Science, society, and government in Africa.* This issue involves public understanding of science and