United Nations

A/62/308

General Assembly

Distr.: General
27 August 2007

Original: English

Sixty-second session
Item 60 (c) of the provisional agenda*
Eradication of poverty and other development issues

Human resources development

Report of the Secretary-General

Summary

The General Assembly, in its resolution 60/211, recognized the increasingly important role that science and technology play in the development of human resources. In particular, it recognized the need for the strategic and innovative use of information and communication technologies in national development policies and programmes to facilitate education, training, knowledge-sharing, recruitment and job creation. The present report responds to the mandate contained in that resolution, which requests the Secretary-General to focus on the role of science and technology in promoting human resources development. The report addresses the challenges and opportunities of using science and technology for human resources development. It explores strategies, especially through the use of information and communication technologies, to promote technology learning and maximize the benefits of technological innovation so as to empower people and expand their economic and social opportunities. The report draws on regional and national experiences and considers the role of the United Nations system in promoting science and technology for human resources development.

* A/62/150.

07-49106 (E) 250907

Contents

I. Introduction

1. The General Assembly, in its resolution 60/211, recognized the increasingly important role that science and technology play in human resources development in developing countries. It encouraged the strategic and innovative use of information and communication technologies in national development policies and programmes to facilitate education, training, knowledge-sharing, recruitment and job creation. It also requested the Secretary-General to focus on the role of science and technology in promoting human resources development in his report to the Assembly at its sixty-second session.

2. The present report examines the challenges and opportunities that science and technology present in developing human resources. It also explores effective strategies, especially through the use of information and communication technologies that promote technological learning and increase the effective use of technological innovation.

3. Science and technological innovation can overcome important barriers to progress. For example, biotechnology has provided a way forward in agriculture and medicine and offers potential to tackle major health challenges facing the poor. Hydrogen fuel cells and gas-fuelled microturbines have the potential to become economically viable cleaner energy alternatives. Information and communication technologies can facilitate access to basic social services and to knowledge, training, jobs and markets, especially for women and girls and other disadvantaged population groups.

4. Human development is not conceivable without access, assimilation and application of technological knowledge, which empowers people and expands their capabilities and opportunities for social and economic progress. Learning to use and adopt new technologies has become vital to function and progress in the global economy.

5. Globalization, involving greater mobility, connectivity and interdependence of markets, has tremendously accelerated the pace of technological innovation, propelled by international competition and globalized production networks. To participate effectively, a certain minimum threshold of skills and knowledge is required. Minimum entry-level skills are higher then ever before. Specialized education and training have become more important and technology support more essential. The limited resources available to invest in human and physical capital and the absence of proper organizations and institutional arrangements to support science, technology and innovation make it difficult for developing countries to keep up with the rapid technological change. The risks associated with the new technologies and the new global regime of intellectual property rights further complicate the challenge by putting new pressures on the set of skills and organizational practices within enterprises, universities, research and development institutes and manufacturing sites to facilitate technology transfer and innovation.

6. However, science and technology offer important opportunities to bridge the technological divide. The employment of new and emerging technologies, especially information and communication technologies (ICTs), provides new and more cost-effective ways to stretch development resources. ICTs can both enable developing countries to pursue more effective development solutions and to foster knowledge flows and learning. Reaping the benefits of science and technology in developing

countries requires a new approach that places technological learning at the centre of national development strategies.

II. Challenges and opportunities to use science and technology for human resources development

A. Challenges

7. Scientific and technological knowledge cannot be simply transferred and applied. An important lesson learned from the experience of past decades is that imported technology needs to be matched with local engineering capabilities. Upgrading engineering capacity would not only ensure the maintenance of imported machinery, but would also enable capacity-building to adapt and use technology for broader applications. Cost-effective and viable technology transfer involves considerable investments in technical skills and physical infrastructure in a mix of institutional, technological and organizational elements that allow the acquisition, use and diffusion of new technologies. The total cost, at the end, might be very high.

8. Developing countries often lack the basic capacity to absorb and benefit from new technologies. They have limited resources to invest in technical training and build an adequate pool of scientists, technologists and engineers. Such a pool would consent to evaluate, assimilate and apply new technologies to local needs and constraints, and to adapt to rapid changes in knowledge requirements so as to ensure maintenance and sustainability, and to manage risks.

9. Universities, technical institutions, professional associations, research and development institutes and laboratories are among the most critical resources to build indigenous capacity essential for economic and technological transformation. Investment in these institutions is often too low in developing countries. The number of such institutions is generally far below the requirements and their quality is uneven. High-quality institutions are few and the demand far exceeds the supply of coveted posts available.

10. They also tend to be isolated from the local productive sector where technological capabilities accumulate and are commercialized. The divorce between research and development and the relevant stakeholders in the productive sectors is one of the reasons for their low rate of innovation in many developing countries. Research and development capacity tends to be scattered across a wide range of independent research institutions which are not organized under a specific research programme or a specific technology target. Their disconnect from the activities of relevant actors makes the transformation of knowledge and research into commercial ventures very difficult. Technology innovation hubs, such as Bangalore in India or El Ghazala in Tunisia, that bring together research institutes, business and venture capital are useful examples of the benefits of twinning research and business.

11. With the exception of some East Asian countries, most developing countries have given education in science and technology a low priority. Technical and vocational education training is very low in Africa, where tertiary enrolment has included only 6 per cent of the population aged 20 to 24, compared to 23 per cent in other developing countries. Educational curricula of universities and technical institutes are inadequate for technological learning, and graduates are not equipped

to participate in the new and emerging technologies and in innovation. In Africa, the share of enrolments in science and agriculture is approximately the same as in other developing countries, but the share of engineering enrolments is just over half the level in other developing countries. The limited pool of design and engineering skills is further depleted, either by the massive outflow of skilled workers abroad, driven by the lack of job opportunities at home, or by poverty and disease, which lowers the return to technical education.

12. Another important challenge for developing countries is the lack of sufficient and reliable infrastructure. In an era of globalization and knowledge-based economies, the quality and functionality of ICTs as well as logistic infrastructure are essential to operate and diffuse the new technologies. Poor infrastructure constitutes a barrier to both progress and learning, especially for the poorest and most marginalized groups of society.

13. The recent strengthening of the global system of intellectual property rights has changed the rules for acquiring technological innovation. The new intellectual property global regime has raised the value of technology, which has become a key driver of business competitiveness in international trade. The intellectual property rights regime provides greater incentives for developing countries to invest in research and development and foster innovation in the productive sector. However, in many developing countries, the research and development capacity is too limited to take advantage of this opportunity. Most of the research in new technologies is still conducted in developed countries.

14. Strong enforcement of intellectual property rights in developing countries might attract more multinational corporations and foreign firms encouraged by the legal protection of their knowledge and technology. The establishment of the intellectual property rights system itself, however, reduces the opportunities and increases the costs of transferring technology. There is also no evidence that intellectual property rights enforcement facilitates technology flows. Patents limit the use and diffusion of technology imported with foreign direct investment and raises the prices of essential products such as drugs and educational material for university students.

15. Many argue that the intellectual property system inhibits the acquisition, adoption and diffusion of new technologies, because of the costs and limitations imposed on developing countries.

16. The risks associated with new technologies present another challenge for developing countries' technological development. The Internet, for example, has spawned a host of cybercrime. Genetic engineering has given rise to food safety concerns and broader developmental concerns. The increasing use of electronic devices and their rapid turnover have generated environmental concerns for the management and disposal of hazardous waste.

17. These risks are not always easily predictable. They are hidden costs of technologies, especially the costs of environmental and health risks. To be able to gauge the risks of new technologies and identify ways to avoid devastating consequences require capacities that are often not available in developing countries.

B. Opportunities

18. Today's technological advances can accelerate economic and human resources capacities in many areas. Medical breakthroughs lower mortality rates. Higher agricultural production entails better seeds, better water use and more productive fertilizers. ICTs provide low-cost communication and facilitate information flows. Manufacturing technologies drive industrial expansion, employment and incomes.

19. Most technologies, however, are not easily available to developing countries because of the lack of basic technological capabilities to absorb them. Taking advantage of technological innovation requires capacity to select technologies that help developing countries the most to build their capabilities to meet their needs. Basic ICTs, such as cellular phones and the Internet, are among the most accessible and cost-effective technologies for developing countries that also provide numerous other advantages. They require less initial investment in capital and infrastructure than technologies in more traditional sectors and can facilitate technological advances in other fields, for example, the agricultural, manufacturing and service sectors.

20. The Tunis Agenda for the Information Society of the World Summit on the Information Society[1] underscored the significant contribution that ICTs can make to achieve the goal of universal education, create an enabling environment for lifelong learning and improve professional competencies and technical skills, including knowledge of health and environmental issues, and agricultural know-how. The World Summit on the Information Society also stressed the importance of improving access to ICT for all and of implementing effective training and education, especially in ICT science and technology.

21. ICTs allow low-cost communication across traditional, social and geographical barriers. The Internet has provided a tool that makes possible worldwide dissemination of information and knowledge at virtually no cost. This has an enormous impact on human resources in developing countries.

22. ICTs also offer opportunities for higher quality and more accessible education. Experience with ICTs to date has shown that they can be an extraordinary tool to improve teacher performance and competence, provide chances for continued training, improve teaching and learning methodologies and make education more participatory and better connected to the outside world.

23. E-learning is a cost-effective teaching and training medium for reaching a wider audience with more up-to-date and user-friendly content and better learning results, especially among the poor. It also provides more equitable access to learning and training opportunities for out-of-school children and youths not able to attend school during regular hours and for marginalized groups, such as the urban poor and rural dwellers who live in remote areas. The cost-efficiency and flexibility afforded by various modes of distant education and the ability to re-use well-developed material easily and widely without need for the presence of highly skilled instructors contribute to its increasing popularity as a tool for capacity-building. E-learning is fast becoming a premier means to provide the constant education required to be part of the global workplace.

---

[1] See *World Information Society 2007 Report: Beyond WSIS*, Geneva, May 2007

24. ICTs also have the potential to build a critical mass of scientists and engineers to drive national development processes. Low-cost communication afforded by ICTs makes virtual research communities across countries far more feasible. Exchange of information worldwide maximizes learning and provides an opportunity for developing countries to draw on the skills and resources available elsewhere, including their own diaspora. Some developing countries have created centres of world-class research for a range of new technologies. This allows them to set priorities for research and generate regional and international cooperation. ICTs also have enormous potential to promote the convergence of many areas of science, engineering and technology by encouraging information flows across disciplines and cross-sectoral research to create new knowledge.

25. ICTs can be instrumental in promoting technological learning and innovation in the productive sector by increasing information on suitable cost-effective technologies. For example, they can be used to demonstrate enhanced farming practices and other new technologies, as well as to introduce novel ideas such as recycling agricultural by-products and cottage industries. This can increase technological learning and training in these practices and the capacity of the workforce to absorb new technologies, including solving related production problems, carrying out reverse engineering and eventually driving technological change. Greater participation of private business in ICTs could facilitate the transformation of knowledge into endogenous technical capabilities.

26. Connectivity can be instrumental to increasing civic participation and the quality and delivery of social services, including extension for the agricultural and agro-industrial sectors. The Internet can also be a powerful instrument to increase local civic participation and mobilization to increase awareness of important developmental issues, as recent successful campaigns on HIV/AIDS drugs and against corruption have demonstrated. Many countries have already put in place and launched e-government facilities and procedures, and public services are gradually becoming computerized, such as e-learning, which has a mutually reinforcing relationship with e-government, e-health, e-farming and e-business.

27. When strategically deployed and integrated into the design of development interventions, ICTs can stretch development resources farther by facilitating the development of cost-effective and replicable solutions. The realization of all this potential requires appropriate government policies to build ICT capacity for all and to promote the strategic use of these technologies to increase knowledge-sharing.

C. Sustainable use of science and technology for human resources development

28. The effective employment of science and technology for human resources development cannot be isolated from the human resources that support them. Technology depends on flows of knowledge and resources, and on mechanisms through which information on specific innovation is shared, developed, commercialized and diffused. Turning technology into a tool for human resources development requires an innovative public policy and investment to build technological capacity and skills in order to access, use and adapt technological knowledge and innovation to local needs and conditions. A deliberate effort in this regard is essential to adjust to rapid technological changes and manage their risks effectively and sustainably.

29. Evidence shows that successful technological transformation requires a comprehensive innovation policy framework centred on technological learning that integrates science and technology policies with industrial policies geared towards manufacturing and export, and an education and research system that supports entrepreneurship.

30. The role of Government is essential to create an environment suitable for the application of science, technology and innovation. Public intervention in this regard should aim at re-aligning existing policies and institutions with this objective and at setting appropriate standards and incentives to mobilize creativity and resources within society. Deliberate measures to enhance awareness of technology benefits and to increase knowledge and demand for more and better performing technology will be necessary to mobilize the participation of key stakeholders: from education and training institutes, to research and development and innovation centres, regulatory agencies, the private sector and financial institutions.

31. Research and development and education are important instruments to promote technological knowledge and learning and critical policy areas for government intervention. Such intervention should promote technology-oriented research and stimulate entrepreneurship. Government strategies should aim at strengthening the links between academia and the productive sector and at encouraging private sector investment in research and development. This would facilitate the involvement of key stakeholders in setting the research and development agenda and in pooling resources to pursue research in priority areas for developing countries.

32. University and industry can be linked in various ways: for example, universities can conduct research that addresses the needs of business and industry, including the risks of employing new technologies; create their own spin-off firms; and participate in capital formation projects, such as technology parks and business incubator facilities. The Government can also use a range of policy options to stimulate enterprise research and development, which will ease the financial burden of universities and research institutes to fund and equip research laboratories. For example, the Government can provide fiscal incentives to local industries (inter alia, tax breaks and low rate loans) to invest in research and development or to co-finance research and development funded through technology funds. International market pressure to keep up with technological innovation provides an important incentive for private firms to invest in research and development.

33. The growing presence of multinational corporations and foreign firms in developing countries provides an additional opportunity to encourage private investment in local science and technology learning. The higher skill level required by foreign companies creates a strong demand to develop the necessary local capabilities to expand business opportunities with these companies. The Government could also encourage foreign companies to invest in local skills.

34. International and regional research networks are other mechanisms to increase knowledge and pool resources for research and development. These mechanisms are crucial to access and acquire relevant technology, especially the newest technologies, at low risk and are particularly useful when developing countries have no access to venture capital to fund research and development. Such networks can therefore play a key role in developing technological capabilities in firms and institutions in developing countries. These arrangements, usually between developed countries, are beginning to be extended to developing countries as well, especially

in agricultural and industrial biotechnology. They have the potential to stimulate biotechnology industries and to generate beneficial new products in developing countries.

35. Partnering with regional networks and research facilities can also help address common local and regional issues, optimize research, promote cost-sharing and lead to mutual gains. Examples of these types of networks are the European Union and Euro-Mediterranean programmes, where research groups from both sides of the sea collaborate in projects related to agriculture, environment and health. International networks can also provide funding for neglected fields of research relevant to developing countries' needs but long underfunded despite the possibility of technological transformations.

36. Today's technological transformation has increased the premium on technological creativity and technical skills and has changed the demand for different types of skills. This calls for a rethinking of education and training policies. Investing in higher education in science, technology and engineering and other advanced technological fields has become essential to create technological capability.

37. Universities and technical institutes in these fields play a vital role in the process of economic transformation. Investing in these institutions and upgrading the quality of their scientific and engineering training are essential to equip graduates to participate in the new and emerging technologies and innovation. The quality and orientation of education should be improved at all levels of learning to ensure sufficient enrolment in scientific and technological specializations at the tertiary level.

38. Educational curricula should be upgraded to match the needs of industry, especially ICT industries, to be relevant for the productive sector and society at large. The increasing application and rapid development of ICTs in various sectors of the economy, from manufacturing, to banking, health care and education, make enrolment and training in ICT science and technology critical for developing countries.

39. Technical and vocational education in the private sector is essential to increase technological learning and innovation at the level of firms and to facilitate the emergence of a class of entrepreneurs that can increase technological development. Technical and vocational training is also essential to promote a culture of lifelong learning focused on the continuous upgrading of skills to respond to the changing demands of technology. The Government could establish training centres with the involvement of the private sector or encourage industry associations to establish and manage such centres through fiscal incentives. Training programmes for self-employed entrepreneurs, farmers and those in the informal service sector could also be developed. Entrepreneurs could benefit from computer-assisted workshops and refresher courses on commercial skills, including information on import-export requirements and ways to link with businesses abroad. Small-scale food preparation undertakings, mostly dominated by women, could benefit from video demonstrations to improve flavour, expand choice and ensure hygiene. Farmers could benefit from on-the-job-training on the management and use of specific technologies for soil and water conservation and livestock production.

40. Rapid technological change and limited resources and infrastructure make it necessary for developing countries to find new ways to sustain technological learning. Universities and research institutes can enhance their relevance, quality and resources by developing partnerships with a variety of stakeholders at the national and regional levels. Creative partnerships can also be developed on non-profit initiatives and with philanthropic organizations. This might expand investment in technologies in fields most important for developing countries. An example of this type of partnership is the one between the Novartis Institute for Tropical Diseases and the Singapore Economic Development Board, which seeks to make new drugs (initially for tuberculosis and dengue) available for poor people in developing countries at the lowest possible price.

41. An increasing number of developing countries are beginning to successfully link public science and technology-related institutes with the private sector and academia so as to link research and development activities and education to the productive sectors of the economy. This has brought dynamism, relevance as well as financial benefits to the participating entities along with a more rational use of national resources. Occupational competence has also been sharpened and professional morale boosted by working and learning synergies.

III. National and regional experiences and lessons learned

42. The needs and capacities of human resources in developing countries vary considerably, especially among regions of the world. Countries have addressed their needs for technological innovation in different ways and with different degrees of success, depending on their developmental stage and understanding of the benefits of science and technology for human development.

43. The Indian ICT industry has emerged as a significant driver of the country's economy. Building on the vast potential of the ICT industry, India has made its education more and more industry-relevant. Enrolments in higher education increased considerably in the 1990s, from 5.3 million to 7.7 million between 1991-1992 and 1999-2000. ICT industry-academia partnerships and alliances between the formal and non-formal sectors of education have created a large pool of English-speaking and technically skilled workforce, especially in science, engineering, information technology and research and development, who can harness existing technological knowledge to improve productivity and welfare. Information technology global sourcing has become a key driver of India's competitiveness, along with ICT growth. In 2006, India achieved 21.1 per cent growth domestically and 34.6 per cent in exports, surpassing its original targets in ICT trade. Projects across most states of India are promoting the effective use of ICT to bring benefits and to change the lives of Indians. The declining trend of information technology professionals leaving India, especially in cities like Bangalore, and those projected to return, are indications of greater policy consistency between the education, science and technology and productive sectors.

44. In China, one of the objectives of the tenth five-year plan (2001-2005) was to develop science, technology and education. The plan explicitly focused on nationwide education and ICT training, in primary and middle school, and on developing ICT industry and infrastructure. China aimed at establishing 6,000 distance education centres in western China by 2003 and to connect 90 per cent of

primary and secondary schools to the Internet by 2010. Another long-term goal of the plan was to foster the information technology manufacturing, telecommunication and software industries. For years, the Chinese educational system has been geared up to meet the demand for software engineers who can compete in the global marketplace. Several Chinese academicians entered software engineering research in the early 1980s. Software engineers are now graduating from university and entering the marketplace to compete in the outsourcing global market. China has also actively invested in building competitive ICT infrastructure and telecommunication providers, such as China Telecom, China Unicom, China Mobile, China Netcom, JiTong Communications Company and China Railway Telecom. Informatization has become a key priority for the modernization of the country and for transforming its population into a pool of valuable human resources.

45. In Bangladesh, the country's poverty reduction strategy paper, which treats science and technology as a priority area, recognizes the need to integrate science and technology learning in primary, secondary and higher education so as to build technical skills in order to access and use technological innovation. This has resulted in a greater number of women and men with degrees in scientific disciplines, qualified for advanced technological professions. The lack of opportunities in science and technology, however, has also meant that many qualified workers have entered fields not related to science and technology. There are a number of initiatives in the country, such as the National Science and Technology Fellowship, aimed at addressing this problem by providing training to science and technology graduates in various scientific and technological professions. The objective is to create professional opportunities for qualified persons and to develop a cadre of scientists and technologists to meet the shortage of such resources in the country.

46. At the regional level, the Asia-Pacific Economic Cooperation (APEC) Human Resources Development Working Group has developed a number of important initiatives at the regional level to promote science and technology learning and applications such as the APEC Cyber Education Network, the Knowledge Bank of Policy and Practice, the APEC Cyber Academy Project and its study and seminars on best practices and innovations in the teaching and learning of science and mathematics at secondary level. Other initiatives in progress are the APEC Learning Standards for English and Other Languages, the APEC Business Schools Network, the APEC Learning Community for Shared Prosperity, the APEC E-Language Research Consortium, the APEC E-Learning Training Centre, the ICT Model School Network, the Future Education Consortium and the APEC Future Education White Paper.

47. Romania has developed a multi-projects programme under the heading Cre@tive Romania, whose common purpose is to build functional e-Government with an e-health and e-education programme that can build a strong human resources foundation for the Romanian information society. The programme comes with the Knowledge-Based Economy project, which aims at building local community networks interconnected for the purpose of providing access to communication services, and the Telecentres project, which contributes to decreasing the digital divide between rural and urban areas and fostering affordable electronic communications throughout Romania via access points in rural areas. Developing high-speed networks for research and education puts Romania on the innovation map.

48. Brazil has embraced the view of technological innovation as an essential element to ensure human progress, social inclusion and development for developing countries. It has promoted a number of initiatives aimed at reducing the digital divide in the country and promoting social inclusion. The programme "Gouvernement életronique d'accueil du citoyen", in Brazil, has made it possible for more than 5 million people in 2,500 cities to access the Internet, with 22,000 computers connected. The Telecentres, "Casa Brasil", have made it possible, for the most disadvantaged populations in rural areas, to have free access to the Internet, e-mail, banking services and other virtual services. The initiative "PC Connected" allows the purchase of computers with Internet access at discounted prices.

49. Chile has started an important educational reform aimed at the introduction of science and technology in its education and innovation system. New teaching and learning methodologies are being implemented at all levels of education to enhance the quality and equity of public education services with a greater allocation of resources to these efforts. In 1992, Chile launched a pilot ICT initiative, "Enlaces", which interconnects hundreds of schools in an educational network, especially those in remote areas, with the objective of replicating this initiative for a wider range of public schools. In 1995, "Enlaces" became the 'official' nationwide initiative for the introduction of ICT to the Chilean educational system. The project was able to expand the coverage to the national level without sacrificing quality or equity and built an important social network of educators and pupils facilitated by user-friendly technology and decentralized support.

50. African countries have in the past been severely constrained by the lack of infrastructure in harnessing science and technology for their development. In many countries, communication networks were destroyed during years of civil conflict, while continuing political instability has deterred Governments and companies from investing in new systems. Currently, however, a number of initiatives, both at the regional and country levels, have begun to emerge that aim at increasing the use of ICTs to build technical capacities and skills in African countries.

51. At the regional level, the New Partnership for Africa's Development has put in place an e-Schools initiative for 600,000 primary and secondary schools in Africa aimed at imparting ICT skills to students and teachers in order to enhance teaching and facilitating school management through ICT. The e-Schools will also be used to promote health literacy. Moreover, the initiative aims at making use of e-learning techniques and encouraging private sector partnerships. Their long-term plan is to encourage in-country partnerships to aid development in the continent.

52. At the country level, a number of countries have recognized the need for science and technology for national development over the last decade and have begun to take action in this regard. Many initiatives focus on increasing ICT access and skills among the population and to extend its use to enhance the quality of and access to education.

53. In Uganda, the National Innovation Fund supports over 20 small-scale innovations in various fields, including farm mechanization, post-harvest storage, irrigation, food processing and natural health-care products. One of the largest initiatives in the country to encourage the integration of science and technology and ICT in school education is Uganda Connect (UConnect). The initiative promotes the use of ICT to improve the quality of public education, health, agriculture and other sectors. Two hundred and fifty-six schools throughout the country currently benefit

from this initiative, while officials in 22 rural districts are being trained on site in ICTs and the Internet by the UConnect team. These efforts aim at increasing technology literacy and efficiency among teachers, managers and government officials. SchoolNet is another initiative that aims at transforming the Ugandan educational system. It works in partnership with all Ugandan educational institutions to set up their ICT facilities and to develop the technical and pedagogical capacity necessary to use ICT to enhance teaching and learning, including professional training to develop ICT skills and facilitate skill transfer.

54. In addition, the Millennium Science Initiative finances high-quality research, undergraduate science and engineering programmes, academia-private sector partnerships, student internships, science and policy and integration of science in schools and communities. Its objective is to increase and retain a pool of highly trained professionals in science and engineering relevant to the country's development needs. The Women of Uganda Network (WOUGNET), a non-governmental organization established in 2000 by women's organizations in Uganda, focuses on developing the use of ICTs among women as tools to share information and address challenges collectively. WOUGNET has four major programme areas: information sharing and networking; technical support; gender and ICT policy advocacy; and rural access.

55. In Tanzania, the link between science and technology and human resources development is well recognized. The Ministry of Higher Education, Science and Technology embodies the vision that higher and technical education and science and technology are key to developing human resources for economic growth. The Ministry of Education and Vocational Training also focuses on promoting a science and technology culture at all levels of education to ensure that technological knowledge and its application permeate society and enhance productivity. In recent years, Tanzania has made progress in promoting the use of ICTs. In 2003, it adopted a national ICT policy across important sectors, such as education, manufacturing, health and tourism, in response to the poor harmonization of ICT initiatives that had led to different systems and standards, duplications and inefficient use of resources. This policy is intended to strengthen ICT infrastructure and overcome the lack of adequately trained and skilled personnel, which are the main obstacles to the broader use of ICT in the context of the national development agenda. This includes the creation of appropriate institutional arrangements to enhance the capacities of all relevant stakeholders, such as Government, the private sector and civil society.

IV. Role of the United Nations system in promoting the use of science and technology for human resources development

56. International organizations, especially United Nations agencies, can play a critical role in promoting the application of science, technology and innovation for the achievement of development goals. They can provide guidance and coordination, set norms and standards and provide scientific and technical advice, including on the application of relevant institutions and legislation, such as the intellectual property rights regime. They can also facilitate the creation of networks among science and technology institutions for the compilation and dissemination of databases on research and development activities and the identification and formation of centres of excellence as a means of promoting subregional cooperation.

Several United Nations agencies provide this type of assistance in their focus areas, with programmes and activities ranging from technical training to capacity-building and infrastructure support.

57. The United Nations Conference on Trade and Development has developed several programmes and projects to train technically skilled professionals to use ICTs in various fields. “Network of Centres of Excellence” is a capacity-building project that provides long-term training and workshops for scientists and engineers from Africa. “Connect Africa” provides country-specific training for ICT engineers and technicians from African least developed countries, as well as hardware equipment for public social service delivery. “TrainForTrade” is a demand-driven programme for training and capacity-building on international trade, trade-related services, investment and port management. It makes extensive use of ICTs, combining distance and face-to-face training.

58. The Information Telecommunication Union (ITU) works with networks of regional and local experts, such as the Union’s e-Learning Centre and specific projects, such as the “Centres of Excellence”, the “Internet Training Centres Initiative” and the “Tap on Telecom Network” initiatives, to train participants in various ICT skills for disadvantaged groups. ITU will soon launch a follow-up project focused on small ICT businesses, with the objective of encouraging local ICT entrepreneurship and forming an ICT skilled workforce able to compete in the global market. The ITU e-Learning Centre currently runs 60 online courses a year, with more then 1,000 registered participants. The objective is to build a series of regional hubs to form a global network running a large share of ITU capacity-building activities.

59. The World Bank focuses on: building developing countries’ capacity for science and technology training at all levels of education; research and development; private sector capacity to absorb and utilize existing technology; science and technology policy capacity; and ICT capacity. Projects in these areas include: vocational training; technical education and training; higher education; learning centres and networks; labour force development and lifelong learning; new learning techniques; and the Millennium Science Initiatives (MSI) Centres of Excellence. The Global Information and Communication Technologies (GICT) Department supports developing countries in building human capacity to use ICT in education as a pedagogical tool, as well as to build people’s technical skills in ICT-related sectors.

60. The International Fund for Agricultural Development (IFAD) has engaged in supporting capacity-building and human resources development through its research and development grants since 1998. IFAD relies on the creation of multi-actor learning settings and the development of collaborative knowledge generation and management capacities, which stimulate innovation through closer interaction between scientific research and farmers’ experimentation and innovation dynamics. IFAD-financed programmes include collaborative research and joint farmer-researcher’s experimentations to improve innovations (for example Farmer and Biodiversity Fields in the Sahel); to define new professional qualifications for extension officers and researchers; to involve university students and professors, both from the North and South, in field activities in order to support farmer innovations and promote interdisciplinary approaches; and to create a new institutional environment that strengthens the linkages between agricultural

knowledge information systems and various actors at the global, subregional, national and community levels.

61. The technical assistance and capacity-building sector of the World Intellectual Property Organization focuses on building legal and administrative capacities to protect intellectual property rights. An increasing number of developing countries are now requesting the organization's assistance in the next stage of optimizing the economic and cultural value of such rights. The Asia-Pacific Industrial Property Centre (APIC) has provided training courses and held seminars for countries in the Asia-Pacific region to help increase the understanding and capacity of government and private sector personnel regarding intellectual property rights.

62. The International Labour Organization (ILO) is currently focusing on the role of vendors of ICT products in responding to the scarcity of information technology skills. The ICT vendors have developed a global flexible skills development system that facilitates access to ICT skills and credible certificates for workers in many African countries through, inter alia, Internet-based courses, e-learning and compact discs. ILO also promotes social dialogue through a Tripartite Regional Seminar on Skills and Employability in Telecommunication Services in selected countries in Africa to enable participants to share experiences, discuss challenges, review their roles in improving training and work organization, and identify follow-up activities to be developed and carried out within the action programme on "Skills and Employability in Telecommunication Services in 2007".

63. The International Atomic Energy Agency (IAEA) technical assistance in the African region focuses on the provision of technical cooperation resources and technology in the form of training, expert advice and equipment. It contributes to the implementation of larger projects in which nuclear components are applied. With the contribution of other donors, these projects blossom into programmes in high priority development areas. In the area of health, the establishment of a number of cancer therapy facilities in the African region has been a major achievement. Since IAEA has been involved in human health in Africa, more than 30 nuclear facilities have been set up, at least 5 radiotherapy centres have been built and 40 radiation facilities have been upgraded. Current technical cooperation activities have focused on strengthening the engineering and technology capacity of developing countries to use nuclear technologies for water resource management, nuclear medicine, and radiotherapy.

64. The United Nations Institute for Training and Research (UNITAR) provides innovative training and research on knowledge systems to strengthen human resources capacities of developing countries and economies in transition. UNITAR has progressively introduced new ICT-based methodologies, such as e-learning, in a number of its programmes, complementing traditional training. In addition, UNITAR has provided policymakers with skills-building and policy-focused training on key issues related to ICT policy and governance. In all its activities, UNITAR, in cooperation with strategic partners, seeks to address ICT policies and solutions adapted to the specific needs and constraints of developing countries.

65. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has launched an Open Training Platform project focused on capacity-development needs in developing countries in 21 key domains for local and individual development, such as, inter alia, adult literacy, water, agriculture, environment, community development, information and technology,

entrepreneurship, health and sanitation, gender issues and AIDS. The project provides access to over 850 training resources worldwide through a central access point that allows tailored research of existing human development materials. The upcoming UNESCO medium-term strategy will give new emphasis to the use of science and technology for human resources development that will address an existing weakness in many developing countries' human and institutional capacities. The strategy will underline the need to focus on human and institutional capacity-building in core areas of the basic sciences, engineering and technology.

66. The United Nations Human Settlements Programme (UN-Habitat) has focused on strengthening human resources capacities to use appropriate technologies in urban management and governance. UN-Habitat has recently adopted Web-based distance learning as a tool to deliver training courses and facilitate capacity-building. "Virtual roundtables" have enabled, with little cost, a wide range of experts from different regions to contribute. In partnership with the Helsinki University of Technology, UN-Habitat and the United Nations Environment Programme will be conducting training for policymakers, urban planners, researchers and civil society on sustainable urban planning that will combine interactive training, research and field visits focusing on innovative planning methods and technologies in the areas of housing, energy, waste management and transport. The UN-Habitat medium-term plan for 2008-2013 aims at strengthening its links with universities and enhancing the role of education in promoting sustainable urbanization. The aim is to create a new generation of planners and urban development practitioners prepared to cope with the global challenges of sustainable urbanization and to harness science and technology for achieving it. UN-Habitat has also established a global network of institutions and a partnership programme with the private sector (Environmental Systems Research Institute) to provide geographical information systems software and e-learning tools in support of key urban trends and indicators monitoring. The programme provides up to 1,000 municipalities with geographical information systems software, e-learning tools and technical support on a grant basis for up to one year so as to complement local government efforts to improve urban data collection and analysis for urban planning and management.

67. The United Nations Children's Fund (UNICEF) has engaged with diverse partners in the use of ICT for education. In Maldives, a UNICEF project will establish Teaching Resource Centres to raise teachers' professionalism and involvement. They will be equipped with VSAT broadband Internet capability that will become a hub in the national e-learning network. A teacher training website is being designed to facilitate information exchange, curriculum review and adaptation, and sourcing and review of curriculum supplement materials. In Mexico, UNICEF supports the use of ICT as a means of communication between children in different states. UNICEF has developed a novel communication technology platform with an application, mepemepe.com, which functions as an interactive classroom, project space, art gallery, document-creation engine, resource and databank and social network for and about children. Mepemepe.com is specifically designed to work in areas with very limited connectivity, requiring extremely low bandwidth, and across a variety of hardware options, from desk to cellphone, making children and communities interact with each other in new ways. For example, children engaged in a project on HIV/AIDS in Kenya can share their experience and work with children undertaking a similar project in Ghana. UNICEF Uganda is piloting

the application in back-to-school programmes in internally displaced persons camps and in its Girls' Education Movement, which will be a platform to develop statistics and share information among youth groups throughout the country.

68. The Food and Agriculture Organization of the United Nations (FAO) supports numerous initiatives to facilitate access of men, women and children to ICTs in a non-invasive manner in order to reduce the knowledge gap across agricultural sectors and boost national effort to build capacity to use innovative ICTs for development. FAO activities include training courses and e-learning training materials, Web-based or CD-ROM courses and workshops in various areas of agricultural development.

69. The FAO Best Practices website presents case studies, experiences and lessons learned from FAO projects, pilot studies and research, and links to further technical information. The FAO Knowledge Forum website provides a platform for communities of professionals, particularly those in research and science, to exchange their knowledge in various thematic areas of agriculture. The Global Online Research in Agriculture (AGORA), which partners FAO with major scientific publishers, enables students and researchers in developing countries to gain access to scientific journals on food, agriculture, environmental science and related social sciences, either free or at low-cost. FAO has also established the International Information System for the Agricultural Sciences and Technology (AGRIS) for exchange of national scientific and research information from all agricultural sectors. As a follow up to the World Summit on the Information Society, FAO launched the Bridging the Rural Digital Divide programme and the e-Agriculture Community of Expertise to exchange best practices on the innovative use of ICTs in order to support sustainable rural development. The FAO Technical Cooperation Programme provides technical training at countries' request in projects containing ICT-related components, or in the development and use of national agricultural information systems.

V. Conclusions

70. **The capacity to utilize technology depends on the indigenous skills, capabilities and resources available in a country to manage acquisition, absorption and diffusion of technological innovation relevant to its development. An effective and sustainable capability for science, technology and innovation can only be achieved in the context of an integrated strategy to promote technological knowledge and learning. This requires policy and institutional frameworks centred on building indigenous scientific and technological capacity, including research and logistic infrastructure, and entrepreneurship.**

71. **Training and education systems at all levels are fundamental to increase overall awareness of the benefits of science and technology for human welfare and to increase tertiary enrolments in these disciplines. ICTs are especially instrumental in this regard. ICTs can facilitate equitable access to and diffusion of knowledge. Distance learning provides remote access to educational resources and promotes a culture of lifelong learning to adapt skills to rapid technological transformation. The strategic use of ICTs is critical to accelerate technological learning and innovation.**

72. **The promotion of research and development at the local level is crucial to tap into indigenous resources and creativity so as to create new knowledge and innovation relevant to local problems and conditions. Transforming technological knowledge into social, economic and cultural gains requires the mobilization of various sectors of society and other partners at the international and regional levels to enhance research capacity and resources and to create basic infrastructure necessary to build and support an endogenous technological capacity. Partnerships among key actors in the Government, academia and the local productive sector are essential to develop technology-oriented research and bring about long-term technological transformation.**

73. **The implementation of an approach that views science and technology as a system of interconnected capabilities, including governance, education, institutions, advice and collaboration, requires action both at the national and international levels.**

VI. Recommendations

74. **The following recommendations are made at the national and international levels:**

National level

(a) **Formulate comprehensive strategies for science and technology that include investment in infrastructure for electricity, telecommunications and transportation and investment to improve the quality of and access to education at all levels;**

(b) **Increase the participation of all relevant stakeholders, including disadvantaged groups, such as women, youth and populations living in remote areas, in the formulation of policies and strategies for science, technology, innovation and entrepreneurship to ensure their relevance to national development problems;**

(c) **Integrate science and technology learning in all levels of education to increase awareness of the benefits of science and technology for human welfare, enhance scientific literacy and build a strong technological base for development;**

(d) **Expand technical, vocational, craft and utilitarian science education to all sectors of society, especially women and disadvantaged groups, to increase the impact of science and technology on all productive sectors and to promote lifelong learning beyond formal education;**

(e) **Promote the use of ICTs to facilitate more equitable access to training and education on science and technology and the assimilation and diffusion of technological innovation, especially among women and girls and other disadvantaged groups;**

(f) **Revitalize existing research and development agencies and allocate funds in support of scientific and technological development programmes, including financial incentives to encourage local private-sector investment, and**

formulate strategies to encourage multinational corporations to invest in local technological learning and fund local research and development in primary sectors;

(g) **Identify areas in which indigenous science and technology capacity could be enhanced through partnership between universities, colleges, non-governmental organizations, government institutions and relevant institutions and facilities at the subregional, regional and international levels;**

(h) **Establish strong links among all relevant stakeholders in education to ensure that the educational curricula across the full education process meet the scientific and technological needs of developing countries. They should also increase awareness of the risks associated with the use of new technologies, especially health and environmental risks, and how to manage them;**

(i) **Develop institutional frameworks and human resources to manage the process of industrial and technological transformation and to minimize the risks and adverse impact of technical change on human development;**

International level

(j) **Bilateral and multilateral donors should help developing countries to identify areas of technology priority and to assist them in developing core competencies in areas of comparative advantage;**

(k) **Relevant United Nations agencies and other scientific associations and institutions should identify appropriate methods for nurturing and assisting developing countries' education programmes and help developing countries establish viable partnerships with funding institutions, such as multilateral development banks, intergovernmental funds and private funds to run programmes for sustainable capacity-building in science and technology;**

(l) **Donors could help developing countries spearhead regional technology research policies and programmes by helping them identify areas for subregional, regional and international collaboration; identifying and developing existing indigenous facilities; identifying appropriate facilities and centres of excellence at the subregional, regional and international levels with which to collaborate; and strengthening research and institutional networks among them. They could also encourage the establishment of science and technology funds to finance national and regional research programmes;**

(m) **United Nations agencies could support developing countries in raising awareness about the value of science and technology among the general public and among those who have influence on educational policies. To this end, they could promote the development of educational materials for an electronic "virtual education" scheme of relevance to developing countries and explore other opportunities in this regard, such as promoting investment in training for the sustainable management of science and technology equipment;**

(n) **Donors, including United Nations agencies and non-profit organizations, could support developing countries' projects to investigate practices to build their science and technology capability, including through the use of ICTs, in order to help developing countries identify relevant practices for their successful adaptation and application. Assistance could include the**

sponsoring of programmes to improve the quality of and access to technological learning, especially for women and disadvantaged groups, and to promote participation in knowledge networks;

(o) **Donors should support developing countries in formulating science and technology strategies that take into account and address the risks involved in the use of technologies, especially new technologies, such as the environmental and health impact, and include them in their research and development process;**

(p) **United Nations system organizations should integrate, in their policies and programmes, explicit support to build science and technology capacities in developing countries, compatible with local needs, culture and practices and ensure coordination and synergies of efforts.**