

# AFRICA AND THE GLOBAL STRUCTURE OF KNOWLEDGE

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## The Session Abstract

*The development of knowledge economies will benefit all. However, Africa will need strong partnerships, different approaches and specific, targeted assistance to build its intellectual capital. What needs to be done to ensure that Africa benefits from the growth in international education? How will a highly skilled and mobile workforce benefit Africa? This session will look at some ways in which institutions and international organisations can take proactive measures to ensure African countries share in the benefits of internationalisation.*

## INTRODUCTION

In his Millennium Report to the United Nations General Assembly in 2000, the UN Secretary-General, Kofi Annan, stated the obvious when he said that 'knowledge is the key to the new global economy'. As Professor Ali Mazrui, Chancellor of the Jomo Kenyatta University of Technology and Agriculture in Kenya, has pointed out: 'The entire international system of stratification has come to be based not on "who owns what" but on "who knows what"'.<sup>1</sup> Pursuing a similar theme, Professor Calestous Juma, Director of the Science, Technology and Innovations Program at Harvard University, has argued: 'Much of the reference to Africa in international forums has focused on the continent's natural wealth. However, natural resource endowment is not a sufficient basis for economic growth; it must be accompanied by investments in science and technology'.<sup>2</sup> Investment in science and technology implies establishing the foundation for knowledge production.

Africa's opportunities to benefit from international knowledge flows lie partly with the global community and partly with Africa itself. Africa has an abundance of natural resources, but to turn them into national wealth, it would require a capacity to engage in knowledge-intensive processes. These can be obtained through strategic partnerships that African states and universities can establish with other institutions around the world. Through such partnerships, Africa might build its pool of expertise in a wide range of disciplines, such as law, sociology, policy studies, science and technology, and metallurgy, among others. Africa also requires personnel with the capacity to draw connections between mega-policy issues such as sustainable development, environmental management, democratic governance and international cooperation. Education, training, social learning and knowledge creation hold keys to Africa's ability to meet these goals. It is African countries that hold the responsibility to come up with initiatives that can enable them to benefit from the growth in international education. However, the international community has a moral

obligation and responsibility to provide training facilities and other resources with which African states can pursue their initiatives.

In an endeavour to explore systematically the extent to which African countries might benefit from global knowledge flows, this paper will explore four hypotheses around four themes: the global structure of knowledge, the role of leadership, appropriate political-legal structures and capacity building. I will argue that African policy makers need to invest more in education and capacity building, because the sustainable use of natural resources requires the application of specific forms of knowledge. In this exploration, I am guided by one ethical concern, namely that under the present circumstances, knowledge creation in Africa needs to be geared towards alleviating poverty and raising the standards of living. Overall, knowledge production must aim at three goals: human welfare, democratic governance, and socio-economic justice.

### **THE STRUCTURE OF KNOWLEDGE**

Hypothesis 1: Africa remains on the scientific, technological, economic, political and military margins of the world largely because it is a consumer, rather than a producer, of knowledge.

The global structure of knowledge is dominated by the developed world, and Africa is a net consumer of knowledge. No African scientist or economist has won a Nobel prize, and there is no prospect of Africans competing for this prize if the current structure of knowledge continues. As a net consumer of knowledge, Africa applies knowledge that was determined or shaped by non-African contexts. This is largely because knowledge production is a social and political process, which reflects the social, historical, cultural and institutional values of its producers. Knowledge is constructed for a social, scientific or political purpose and for a particular community of scholars or policy makers. In interpreting data, scientists

and other researchers are often influenced by their cultural, social, political and racial values and beliefs. In disseminating the findings of research, scholars often emphasise some facts and ignore others, depending on the audience and their own preferences. As Robert Cox has said: 'Theory is always *for* someone and *for* some purpose. All theories have a perspective. Perspectives derive from a position in time and space, specifically social and political time and space'.<sup>3</sup>

Moreover, when researchers convey their findings, they do so in language, and language cannot be value-neutral. In much of sub-Saharan Africa, this linguistic factor assumes an extra dimension because the language of transmission of existing and new ideas is often a borrowed one: English, French and Portuguese. As knowledge construction, including the production of scientific knowledge, is a social and political process, we need to recognise that while scholars may engage in serious and systematic research and may treat all evidence consistently, they cannot provide completely value-free knowledge. Sometimes scientific knowledge is interpreted to suit the interests of the funding agencies. It is this value-laden knowledge that African scholars and policy makers consume.

The second point about the structure and distribution of knowledge is that the knowledge we have about ourselves and the things that we do is contestable and, in some cases, transient. This suggests that while society may accept and apply today's scientific findings, it should not lose sight of the possibility that these findings may be challenged tomorrow. Let us take, for example, the claim by medical science that peptic ulcer was caused by excessive acidity in the stomach. For many years, antacids were prescribed, and are still prescribed in some African countries, but in the 1980s a study in Western Australia found that the cause of stomach ulcer was not acidity but a bacteria called *helicobacter pylori*. Excessive acidity was the symptom, not the cause. The study established that '100% of patients with duodenal ulcer and 80% of those with gastric ulcer' had *helicobacter*

*pylori*.<sup>4</sup> This was a big threat to the pharmaceutical companies which manufactured antacids, and they initially challenged this finding, 'using' other gastroenterologists and histopathologists to try to discredit the two medical researchers - B. J. Marshall and J. R. Warren - who had discovered *helicobacter pylori*. However, it is now generally accepted that *helicobacter pylori* 'is the cause of most gastric and duodenal ulcers, with elimination of the organism leading to healing of the ulcers and a significant reduction in the incidence of recurrence'.<sup>5</sup>

The attempt to disregard the clinical significance of *helicobacter pylori*, even after logical answers to most questions had been published, was not an isolated case. It has happened many times in relation to environmental issues. For example, it happened at the Kyoto Climate Summit in 1997 and at other conferences called to address the issue of climate change. Scientists sponsored by the petroleum industry tried to discredit the credibility of those who claimed that continued reliance on fossil fuel exacerbated the greenhouse problem. The contestation of knowledge in science often follows a pattern. Generally, a problem would be identified. Scientists would be asked by policy makers to present their best research findings on it. However, if the findings were seen not to be politically expedient, the policy makers would disregard the science. In such a case, if the scientists persisted in calling attention to their data, they would be labelled dissenters and their reputations attacked. The implication of this contestation is that Africa, as a net consumer of knowledge, receives only that type of knowledge, which the knowledge brokers in the developed world consider to be socially and politically palatable.

The third point about the structure of knowledge is that Africa's low socio-economic position vis-à-vis other parts of the world is, in large part, a function of the global distribution of knowledge, ideas and technology. More than 150 years ago, Karl Marx argued that it was the substructure or economic base that determined the superstructure or prevalent ideas and institutions. The situation

might have looked like that during his time, but it is no longer so. In this epoch, the global structure of knowledge and ideas plays a very important role in determining the global structure of political and economic power and influence. Societies which are rich in natural resources but poor in knowledge and modern technology, like most of African states, may not succeed as well as those which have both knowledge and resources. Indeed, the states that are rich in knowledge and modern technology, but poor in natural resources, are likely to have greater global influence. This is why a resource poor country like Japan is richer and globally more influential than a resource rich country like the Democratic Republic of Congo. However, this situation can be reversed through strategic leadership, capacity building, appropriate political-legal structures and the revamping of universities in a country like Congo.

The current global structure of knowledge makes it abundantly clear that the way forward for African countries is to develop their human resources and knowledge base. They need to invest more heavily in education, from primary schools to universities. There is an urgent need for African policy makers to pay more attention to the training of specialists, especially in science and technology, but also in other disciplines. Indeed, the most effective way for African countries to convert their natural resources into national wealth and emulate countries like Singapore and Taiwan, is to address the knowledge gap. In addressing this knowledge issue, policy makers should always bear in mind the fact that whatever knowledge resources they acquire should be geared towards improving human welfare. This is not to imply that knowledge has always to be assessed in terms of its visible or immediate relevance to existing political, social, economic or health problems. What I mean is that, given the present level of the economic, scientific and technological capacities of African states, education will benefit them more if it is geared towards sustainable development and human welfare. The international

community can play a vital role in providing training opportunities for African researchers and policy makers.

The final point about the structure of knowledge is that there are at least four sources of knowledge in Africa. The first source consists of indigenous knowledge producers, and if Africa is to succeed, it will need to work closely with this group. The second source consists of home-based African researchers and scientists. Some of these people are doing very good research, and international efforts aimed at assisting African countries to build their intellectual capital need to explore ways of establishing strategic partnerships with members of this group. The third source consists of expatriate knowledge brokers, whose knowledge of African conditions varies from excellent to mediocre. If Africa wants to succeed in developing viable strategies for the creation of knowledge through its universities and research institutes, it has to take risks with expatriate knowledge sources. The fourth group of knowledge creators in Africa consists of African scholars and scientists in the diaspora. Some members of this group have been exploring ways of networking with their counterparts in Africa to try to revamp African universities and research centres. For example, in 2001, I participated in the launch of the African Millennium Initiative for Science and Technology (AMIST) through the UN University Institute for Natural Resources in Africa (UNU/INRA). One of the aims of AMIST is to bridge the knowledge gap between home-based African scientists and academics, and their counterparts in other parts of the world.<sup>6</sup>

Knowledge creation is one thing, but establishing social, political, economic, and legal structures under which scientific innovations are absorbed and utilised is quite another. The latter requires, among other things, strategic leadership.

## **THE ROLE OF LEADERSHIP**

Hypothesis 2: African countries and tertiary institutions require strategic leadership in order to benefit adequately from the growth in international education.

It is generally acknowledged that leadership entails a vision, inspiration, goals and strategies. Strategic leadership is crucial for the establishment and consolidation of conditions in Africa that are conducive to the production and utilisation of appropriate knowledge. Such leadership is also vital for the attainment of sustainable development, the national interest and security. Strategic leadership has to be conceived and exercised within a system of shared values, rules, norms and principles, not in a moral vacuum. In particular, state and government leadership has to be underpinned by the ethical principles that were mentioned earlier: human welfare, democratic governance and socio-economic justice.

The term leadership conjures up the image of an exemplary figure; of someone who can help others set goals and achieve them. It also implies the capacity to control, shape or direct an entity, an activity or a process. This capacity requires creative and imaginative thinking, innovation and entrepreneurship. Leadership has to be defined in terms of driving or motivating an organization, a state, a government or any group to achieve something. It is ability, willingness and a commitment to mobilise and utilise the best resources, operational skills and techniques available to attain a given goal or resolve a problem. In other words, good leaders must demonstrate a commitment to seek the best means, or make the necessary sacrifices, to pursue the goals that they have set or provide a solution to an existing problem. They should also be able to motivate or inspire their constituents to pursue their goals with confidence. Africa needs strategic leadership in order to establish strong international partnerships through which it can build its intellectual capital.

Leadership is diversified and dispersed in society. For example, in African states there are leaders of government, universities and other centres of learning, the business community, trade unions, farming community, and the professions.

Therefore, when the term leadership is used, it applies to political as well as non-political leaders. There is often a tendency to associate leadership with status or high offices, such as those of prime minister and president of a country. This may be correct in relation to certain individuals, but it may also be incorrect in relation to certain other individuals who may occupy high office. It is possible to have a prime minister or president of a country who has no leadership qualities. It is also possible to have a vice-chancellor or president of a university or a principal of a school who is not a leader in the true sense of the word. Likewise, in a government there may be permanent secretaries or departmental heads that do not, and perhaps cannot, exercise leadership or take leaderlike initiatives. At the same time, there may be middle or lower level officials who have vision and can inspire others to achieve their purposes. Thus, while it is generally expected that those who occupy high office, such as prime minister or president or vice chancellor, should provide leadership, it is not always correct to associate leadership with status and rank. Even those who do not hold formal positions of power can provide leadership. For example, Mahatma Gandhi provided leadership when he did not hold a formal position of power in India. In South Africa, Nelson Mandela provided leadership while still in prison, and at a time when he did not occupy a formal position in the African National Council.

Many African states and tertiary institutions cry out for strategic leadership, that is, leadership with a clear vision and the capacity to mobilise human, financial, scientific and social resources to meet the national interests. One way in which international organisations can take proactive measures to ensure that African countries share in the benefits of internationalisation is to help train their leaders. They can also provide internship programmes through which future African leaders can be exposed to best practices. The entire continent needs leadership that can help states, governments, universities, and civil societies to work out the most appropriate ways of utilising national resources to meet the goals of democratic governance,

sustainable development and security. Democracy is unlikely to succeed without sustainable development, and without democracy, scientific innovation may be stifled. Hence, the connection between democracy, development and education.

African states also need strategic leadership that can point in the direction of mega-policies that integrate democratic governance, science and technology, sustainable development, environmental management and international cooperation. Subject to the fact that there are possibilities and limitations of leadership, strategic leadership should help to identify the natural resources on which policies should focus, secure markets for national resources, help universities secure strategic partnerships, and initiate productive linkages between internal agents, regional actors and the global community. This leadership should help to develop dynamic state agencies and map out autonomy for such agencies, while creating room for civil society and other non-state actors within. Such leadership is not in evidence in much of Africa, but there is nothing to preclude its emerging in the future. After all, contrary to the old-fashioned perception that leaders are born rather than made, leaders of all kinds can be made. The idea that leaders are made raises the question: Who makes them? The society makes leaders, and the task of policy makers is to provide conditions that are conducive to their social construction. The international community can play a role in helping African policy makers establish such conditions.

### Recommendation

- African policy makers should give top priority to the training, development and nurturing of strategic leaders at all levels of society.
- Policy makers should identify young people who have the potential to be effective leaders and give them opportunities to develop their leadership skills.
- Policy makers should embark on appropriate capacity building programmes.

- The international community should play a role in training African leaders and in providing opportunities for such leaders to be exposed to best practices.

It is through such measures that African states can establish conditions that will attract a highly skilled and mobile workforce. It is also through these steps that African states can be helped to share in the benefits of internationalisation.

### **POLITICAL-LEGAL MECHANISMS**

Hypothesis 3: African countries are likely to have a larger share in the benefits of international education if they establish political-legal mechanisms that permit innovations in science and technology, flexible working conditions, and respect for fundamental freedoms.

A country's intellectual capital is only as good and as strong as the national political, legal and economic structures and institutions permit it to be. It is the political and legal structures of African states that have determined the shape and development of their present knowledge bases. The first goal is to make the conditions for research more flexible and attractive. For many African states, remuneration for scientists and researchers is very low. In addition, there are no incentives for hardworking researchers, and many researchers encounter too many restrictions even on simple research. Obtaining a research clearance certificate, for instance, can take months. The task ahead for African policy makers is to remove these disincentives by redesigning political and legal mechanisms that are accommodating to innovations in the arts, science and technology and other fields. These mechanisms should also permit a full range of fundamental freedoms and liberties. The international community can play an important role of encouraging African states to take these initiatives by funding some of them. It is through such

measures that African states can benefit from a highly skilled and mobile workforce and develop competitive knowledge economies.

The type of political-legal structures and institutions required for African states to share in the benefits of internationalisation may vary from one country to another, and from one continental region to another. Even within the same country or region, they will evolve in response to changing times. However, in the present global environment, appropriate institutions and structures should be able to tackle the need for flexibility in the workforce, accommodate innovations in science and technology, and reform taxation rules, especially those relating to the importation of equipment associated with knowledge creation. The redesigned political-legal mechanisms also need to address effectively human rights, gender relations, environmental issues, and participatory democracy, among other things. It is under such conditions that African states will stand a good chance of benefiting from the growth in international education.

The second goal is to provide a mechanism for integrating science and technology adequately into development plans. Many African states, like other countries elsewhere, are interested in the benefits of science and technology, but some of them lack the basic policy infrastructures to integrate science and technology sufficiently into their development objectives. This may be blamed partly on the lack of strategic leadership, partly on the lack of skilled personnel, and partly on the nature of the political-legal structures of these states. African policy makers can address this issue, in part, by designing legal, social and political institutions and policies that allow for the absorption of new technologies, and the integration of sustainable development, environmental management and resource exploitation. It is through such structures and processes that African states can meaningfully develop competitive knowledge economies. African universities should be proactive in pushing this agenda. And the international community can also play an important

role in this endeavour, because most African states do not have the human and financial resources to adequately pursue these measures on their own.

The third goal is to design institutional frameworks that take account of both global forces and indigenous contributions. Constructing the political-legal structures, institutions and policies of African states in this era of globalisation requires indigenous as well as external inputs. Therefore, it is imperative that African policy makers establish political-legal frameworks for the development of knowledge economies that reflect the changes in global norms while at the same serving the local and national interests. African countries are part of international society, so their political and legal institutions and policies are partly derived from the rules, institutions, values and norms that bind other countries. Establishing political-legal frameworks in Africa must take into account the revolution in biotechnology and biomedical research, international knowledge flows, and agricultural innovations. This is important in two senses. First, it helps to prepare African countries to take advantage of the latest technology to improve their crops, farm in semi-arid areas, and exploit their biodiversity resources. In the second sense, implementing policies that are in conformity with global norms helps to improve the international legitimacy of African governments and their leaders. It also may facilitate the development of strategic partnerships between African universities and their counterparts abroad.

However, foreign institutions cannot be transplanted root, stem and branch into African societies without taking account of African values, norms, standards and practices. It is important to stress the indigenous factor, because structural adjustment programmes (SAPs), which were promoted by the International Monetary Fund and the World Bank from the 1980s, did not take into account the positive aspects of the existing practices. As a result, SAPs were partly responsible for eroding the accumulated technological capacity in several sectors. The new

structures need to reflect as much as possible the progressive values, norms and standards in Africa. The indigenous African people have knowledge about medicine, environmental management and agriculture, among other things, which may be of use in the new millennium. African policy makers and universities need to explore possibilities of utilising Africa's traditional knowledge and expertise, especially on biodiversity. In this sense, African universities can play important roles in setting the breadth and depth of indigenous values that are to be incorporated in the knowledge banks.

This simply means that African policy makers need to show a readiness to promote and experiment with policies and laws that incorporate social learning. Social learning does not always mean borrowing from other countries. It may simply require a greater understanding of the evolving social, cultural, economic, legal and scientific contexts within which African universities operate.

#### Recommendation

- The top priority of African policy makers is to redesign political-legal structures and institutions that facilitate the development of knowledge bases.
- They should establish new political-legal frameworks that embody incentives and flexibility in workplace relations.
- They should create institutions and structures that are geared towards the absorption of appropriate technologies for the conversion of natural resources into national wealth.
- They should build political legal frameworks that provide room for the input of indigenous knowledge.
- They should create political-legal structures that reflect the changing global norms and best practices.

## CAPACITY BUILDING

Hypothesis 4: African countries will benefit more from a highly skilled and mobile workforce if they engage in capacity building that involves the revamping of universities and research institutes.

The term capacity building is often used to refer to a wide range of activities related to learning and the acquisition and use of knowledge. For example, the United Nations Environment Programme (UNEP) has defined capacity building as 'the strengthening and/or development of human resources and institutional capacities. It involves the transfer of know-how, the development of appropriate facilities, and training in sciences related to safety in biotechnology and in the use of risk-assessment and risk-management'.<sup>7</sup> In other cases, capacity building has been used to describe the training of highly skilled professionals such as lawyers, accountants, computer programmers, doctors, specialists in science and technology, and other professionals.

As a process of learning, acquiring and applying knowledge, capacity building legitimises imitation. By this, I mean that through capacity building, individuals are encouraged to adopt the skills, techniques and methods of those whom they perceive as 'successful' and apply them to address problems in their countries. In this paper, I use the term in a limited sense to refer to the building of human resources and societal institutions that are necessary to perform specific tasks, namely the creation of knowledge using indigenous and global sources. It is used, in part, to describe the creation of conditions and organisational structures that are conducive for policy planning and implementation of the best practices in education. It also refers to the short-term and long-term training of expertise that can integrate democratic governance, science and technology policy, sustainable development, environmental management and international cooperation.

Developing institutional capacity remains a high priority. In addition, there is a great need for developing the capacity for strategic environmental assessment that encompasses sectoral and regional approaches. Unfortunately, across the continent at this stage of Africa's development, there are still very few appropriate organisational structures and outfits for capacity building. Yet, the training of highly skilled professionals is vital if African states are to participate meaningfully in the global knowledge economy. Capacity building is crucial for development and for the application of appropriate science and technology.

Successful states like Japan, Singapore, South Korea and Taiwan care more about capacity building than do African countries. They have invested adequately in capacity building, and have been more adept at imitating, and sometimes exceeding, the practices of developed countries. If African states do not invest adequately in education, they cannot be expected to do well in capacity building. Unfortunately, some African universities and other training institutes have been mismanaged, starved of research funds and neglected to the extent that they offer few answers to Africa's needs for capacity building. For example, at the 10<sup>th</sup> general conference of the Association of African Universities in Nairobi in February 2001, it was pointed out that most African universities were 'reeling under mismanagement, political interference and a shortage of funds'.<sup>8</sup>

What alternatives do African states have? The African Centre for Technology Studies (ACTS), based in Nairobi, has made a visible contribution to capacity building. Its books on different areas of science and technology, including biotechnology, have been of great use to policy makers and academics alike. Moreover, in collaboration with the World Resources Institute, ACTS has established a regional training course for African policy makers on the Convention on Biological Diversity. The course covers several areas, including the formulation of national

access and benefit sharing legislation. This is a very important aspect of capacity building, but it cannot be a substitute for formal training.

It has been argued that the UN University Institute for Natural Resources in Africa (UNU/INRA) could provide the required institutional leadership 'to build African capacity in the application of science and technology, particularly in the management of Africa's biological resources and biopolicy'.<sup>9</sup> The UNU/INRA has the clout to assume such a leadership role. Indeed, the UNU/INRA has established an innovative networking system that serves a useful capacity building function. The UNU/INRA College of Research Associates (CRA) provides research, education and training opportunities for African scientists and scholars in different areas of science and technology. CRA members are drawn from various universities in Africa, and while participating in the UNU/INRA programmes, they still remain in their home institutions. Members are usually encouraged to prepare research proposals, which are peer-reviewed. Successful projects become part of the scheduled activities of UNU/INRA after adoption by the Advisory Board of the UNU/INRA. However, the UNU/INRA's efforts at capacity building would still leave a void because it, like its parent University in Tokyo, does not have the mandate to offer degrees or accredited certificates.

What this means is that in the long-term, African states have to look for alternative ways of capacity building. The richer African states might find it possible to train their own personnel in most disciplines, with minimal outside assistance. The poorer states face daunting tasks. They might find it necessary to give their universities strategic leaders, but unless these universities are restructured and funded appropriately, they cannot provide the needed training. There are at least two ways of addressing this problem. One is that the poorer African states might find it advantageous to join forces to build their human capacities. The second is that the

international community has a moral responsibility to help these countries build their capacity for the generation of knowledge.

The choice of what disciplines to emphasise in capacity building is of particular importance. It has been suggested that part of the personnel African states need to build their capacities should train in economic theories 'that seek to place issues such as innovation, human development and knowledge at the centre of the growth process'.<sup>10</sup> There is great wisdom in this view. In addition, those charged with capacity building in African states would also need to consider imparting knowledge that draws the connections between democratic governance, resource use, sustainable development, environmental management and international cooperation. The important thing is that the choice of disciplines to emphasise should change as societies evolve and as the global community changes. In general terms, education or training that links the national interest, environmental management, sustainable development, peace and security would be ideal, although what constitutes each of these issues is subject to reinterpretation at different times. Failure to emphasise these links would produce 'experts' who are liable to repeat the mistakes of the past.

The idea that there are no formal degree programmes in African universities that offer courses that link these mega-policy issues is a matter of regret. Some of the required skills can be acquired through training seminars, workshops, issue networks and strategic partnerships involving personnel from various departments and ministries. Through such *ad hoc* arrangements, African scholars and policy makers may be sufficiently exposed to theories and policy prescriptions that seek to integrate democratic governance, resource use, environmental management, sustainable development and international cooperation. However, this is only the second best option. The first option is to restructure African universities and other educational institutes and equip them to handle these integrated programmes.

### Recommendations

- The first priority for African policy makers should be to revamp the universities and other centres of higher education with a view to training personnel that is able to facilitate effectively the creation of knowledge economies. These universities and centres of learning should liaise with the UNU/INRA to identify areas of science and technology that they can pursue in the future.
- African policy makers should explore opportunities of establishing regional institutes, on the scale of ACTS, to help develop the capacity they need to enhance their knowledge bases. Such institutes are likely to receive funding from the donor community, provided they are competently managed.
- African policy makers and educational leaders need to broaden and deepen research partnerships with industry, as well as with developed and other developing countries. Through such partnerships, they may acquire part of the knowledge and funding they need to help their societies establish strong knowledge bases.
- The political elite should avoid interfering in the management of universities.

These initiatives require the strategic leadership mentioned earlier. They also require people who are able to integrate democratic governance, sustainable development, environmental management, and international cooperation. Moreover, these initiatives need innovation in government, and especially in political-legal structures. It is these measures that will pave the highway for the creation of competitive knowledge economies in Africa.<sup>11</sup>

## CONCLUSION

The first challenge for African policy makers is to facilitate the emergence of strategic leaderships at various levels of society. Whether it is political leaders, business leaders, or leaders in science and technology research, it is these leaders who will inspire the African people to seek newer ways of converting their resources into wealth. The second challenge for African policy makers is to help build the institutional and human capacity, giving priority to the acquisition of expertise in science and technology. This will entail restructuring the universities and other centres of learning, establishing regional research institutes, and broadening and deepening strategic partnerships with successful countries. The third challenge is to construct appropriate political-legal frameworks through which the African people can use new technologies as well as indigenous knowledge to exploit natural resources for the generation of wealth.

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<sup>1</sup> A. A. Mazrui, 'Technological Underdevelopment in the South: The Continuing Cold War' in P. Wapner and L. E. J. Ruiz (eds), *Principled World Politics: The Challenge of Normative International Relations* (Lanham, MD: Rowman and Littlefield, 2000), p. 275.

<sup>2</sup> Calestous Juma, *Science, Technology and Economic Growth: Africa's Biopolicy Agenda in the 21<sup>st</sup> Century*, UNU/INRA Annual Lectures on Natural Resources Conservation and Management in Africa (Tokyo and Accra: UNU/INRA, 2000), p. 49.

<sup>3</sup> Robert Cox, 'Social Forces, States and World Orders: Beyond International Relations Theory', in Robert O. Keohane (ed.), *Neorealism and Its Critics* (New York, Columbia University Press, 1986), p. 207.

<sup>4</sup> C. S. Goodwin, 'Helicobacter Pylori: 10<sup>th</sup> Anniversary of its Culture in April 1982', *Gut: An International Journal of Gastroenterology and Hepatology*, Vol. 34, No. 3, 1993, p. 293.

<sup>5</sup> P. R. Murray, K. S. Rosenthal, G. S. Kobayashi and M. A. Pfaller, *Medical Microbiology*, 3<sup>rd</sup> edn. (St. Louis, Mosby, 1998), p. 256.

<sup>6</sup> See, for instance, A. Uzo Mokwunye (ed.), *Bridging the Knowledge Gap: Revitalizing Africa's Universities* (Accra: UNU Institute for Natural Resources in Africa, 2002), p. 71.

<sup>7</sup> See I. Virgin, R. J. Frederick and S. Ramachandran, 'Biosafety Training Programmes and Their Importance in Capacity Building and Technology Assessment', in S. Shantharam and J. F. Montgomery (eds.), *Biotechnology, Biosafety and Biodiversity: Scientific and Ethical Issues for Sustainable Development* (Enfield, NH: Science Publishers, 1999), p. 6.

<sup>8</sup> Kariuki Waihenya and Samuel Siringi, *Nation*, 11 Feb 2001.

<sup>9</sup> Juma 2000, p. 55.

<sup>10</sup> Juma 2000, p. 54

<sup>11</sup> Some of these ideas were explored in Samuel M. Makinda, *From Natural Resources to National Wealth: Ethical, National Interest and Policy Issues for Africa in the New Millennium*, UNU/INRA Annual Lectures on Natural Resources Conservation and Management in Africa, (Accra and Tokyo: UNU/INRA, 2001).