Professor Calestous Juma memorial lecture

Naledi Pandor MP
Minister of Higher Education and Training
South Africa

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Windhoek, Namibia

"Public Policy Advice for Science and Technology"

1. *Introduction*

I first heard of Professor Juma in 2010 soon after I was appointed Minister of Science and Technology. I received an email (5 March 2010) he wrote to a staff member in the office of the presidency.

> I am writing to enquire if the President of Africa's most powerful scientific nation has a Science and Technology Advisor. If not, please forward this to the right person in the Office of the President so that remedial action can be taken expeditiously.
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> I believe that South Africa should continue to serve as a role model for the rest of the continent on the importance of science and technology. It is for this reason that South Africa's President should have a Science and Technology Advisor. If there are reasons not to have such I position, then I would like to have the opportunity to meet the President to discuss the matter with him.

> I would like to come accompanied by Professor Mohamed Hassan, President of the Academy of Sciences for the Developing World (TWAS) and the Dr. Shem Arungu-Olende, President of the African Academy of Sciences.
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> If such an Advisor exist, please do connect me to him or her and consider the contents of this e-mail moot.
>
> Best regards,
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> Calestous Juma PhD FRS NAS TWAS AAS
> Professor of the Practice of International Development
> Harvard Kennedy School

At the time I thought he was being presumptuous, but I see from his unfinished draft for Namibia that he continued to believe in the importance of presidential science advisers.

I came to know him better after we met at President Obama's US-Africa summit in 2015 and through his subsequent advisory role in the development of STISA. And I am still immensely attracted to three of his key concerns about which he wrote so much: he argued that the bio-economy would transform African agriculture; he wanted African universities reinvented and diversified; and he was keen on the humanities and social sciences and in favour of a new curriculum

2. *Key science and innovation indicators in Africa*

Africa is home to 15% of the world's population and 5% of the world's gross domestic product (GDP) but accounts for only 1.3% of the globe's investment in research and development (R&D). It also holds only 0.1% of the world's patents. However,

a recent World Bank report reveals that there has been a significant growth in sub-Saharan research but notes that inter-african research links are rare. Half of that research is in the health sciences. There is clearly, as the World Bank report reveals, a large scientific base in Africa, but we have work to do in training and strengthening our African research relationships. Our aim is to transform science, technology and innovation in Africa. We cannot thrive in isolation. We are part of an African research and innovation system.

More and more African researchers are broadening their horizons and engaging in much-needed projects in food security, energy, transport, and health (malaria and HIV). This has seen the number of papers from African researchers double in just over a decade, improving in quantity, quality, and international citation according to data from Scopus, the largest database of peer-reviewed literature.

There is more and more funding for African research. This includes the Grand Challenges Africa Grants, $7 million in grants over the next five years for scientific breakthroughs in maternal healthcare and precision medicine in Africa; the Kwame Nkrumah Scientific award from the African Union, $100,000 to top African scientists who provide innovations in life and earth science; the Next Einstein Fellowship, which recognises Africa's distinguished scientists under the age of 42. Neil Turok, Next Einstein founder, tweeted: "When Africans enter science in large numbers, with their diversity, backgrounds & motivation, they will make massive, transformative discoveries. Those discoveries are just waiting there to be made."

The African Academy of Sciences is part of this drive and is doing sterling work to build intra-Africa research and

development partnerships. The Academy's Alliance for Accelerating Excellence in Science in Africa (AESA) manages the $100 million Developing Excellence in Leadership, Training and Science (DELTAS Africa) Programme.

This creates a human-resource pipeline that can sustain this area of research work into the future, and which contributes to the availability of a critical mass of globally competitive African health scientists. We need highly capable African scholars. We need African research leaders able to hold their own in a global environment. We already have some of these. We need many more.

We need to strengthen and build on these initiatives and many others to ensure a robust and sustainable research and innovation sector in all African countries. Increased attention must be given to finding resources to increase our research focus beyond agriculture and health. Young researchers have a wide range of fields of interest. We must support them to explore a diversity of disciplines.

As the 2015 UNESCO science report reveals, there has been a positive shift in research, development and innovation. It shows the success of the AU's first African science technology and innovation Plan of Action. Recently the AU adopted its second African Plan. It prioritises science to drive economic and social development across the continent. It commits signatory countries to six goals, including tackling hunger, disease and unemployment, and will set up structures to pursue them.

We know that breakthrough or frontier science takes a long time and that breakthroughs are immensely difficult to predict. It's all about getting the right balance between funding basic or

frontier science and focusing on particular fields of science in which we know that we want to build new industries.

That is why South Africa has invested so strongly in astronomy. That is why South Africa has invested so strongly in space science. That is why South Africa is investing more in biotechnology and nanotechnology.

We can't do this without the best evidenced-based advice available.

3. *South African science-policy interventions*

A decade ago our innovation system faced three major challenges. First, there was a tension between the different policy processes followed in higher education and science and technology. Second, it appeared that DST targeted strategic and applied research at the expense of basic research. Third, it was apparent that we had failed to increase research output and to develop black and women researchers. In other words, we were still locked into pre-1994 research patterns and practices with a few elite institutions producing the majority of the research output.

However, over the last decade there has been much improvement on these three challenges to our innovation system. Research output has improved, spectacularly in some fields like astronomy. The number of science, engineering and technology graduates has increased, not as impressively as required, but the number of PhDs has, with the milestone of more black than white PhD graduates reached a few years ago.

Our innovation system still has to find the best approach collaboration across government and not just by the DST or DHET or the DTI alone. The complaint is that the DST is too mission oriented at the expense of basic research. It is certainly true that we have concentrated research in a few areas: geographic and knowledge advantages areas, grand challenges, and astronomy (which is both a grand challenge and an advantage area).

4. *Enhancing science capacity in Africa, drawing on the diaspora and research intensive institutions in Africa.*

In South Africa we have tried to put in place the best science and technology policies. We have a separate department to prioritise research. We have made science and technology a national priority. We focus on promoting specific areas for R&D - astronomy, energy, bio economy - in which we are becoming world leaders. We invest in vibrant, knowledge-based activities that are driven by the quality of the scientists we train, the quality of our research and development infrastructure, and the enablers we have put in place to turn scientific research into technology. That's why we invest in centres of excellence, research chairs and national research facilities.

Our greatest challenge lies in providing exciting opportunities to our young people. It’s clear that high-tech innovations will help employment grow over the long term, as new technology spreads from one sector to adjacent sectors and so throughout the economy. But it's also clear that the emerging high-technology sectors by themselves don't employ more people at the moment (innovation works through the "creative destruction" of jobs). However, the future lies in the emergence of the vast field of artificial intelligence and that’s what we are focussing upon.

Let me take the example of the SKA.

I have spent much time with SKA and have developed a deep appreciation of its importance.

On the one hand, big science infrastructure projects like SKA tend to have unexpected spinoffs. It's a telescope but it’s also an IT project of the kind that pushes the boundaries of global technology. Big tech companies are already involved, because they know it will allow them to develop the knowledge and technologies that will keep them at the leading edge of computing.

On the other hand, what can be more important than seeking a better understanding of our origins, how the universe was born, or how galaxies and stars were formed? Astronomy is a discipline that gives context to our place in the universe and a framework for how we see the world.

The construction of the SKA is set to start in 2018, with early science observations in 2020. Producing the thousands of dishes required for the SKA within the project’s time scales will also demand an entirely new way of building highly sophisticated and sensitive scientific instruments, which should lead to innovations in manufacturing and construction.

The completion of the 64-dish MeerKAT last week was one of the crowning moments of my political career.

Africa has made a major investment in the future through the SKA.

Global research infrastructure projects play an invaluable role in focusing the attention of policy- and decision-makers as well as the broader public on science and technology. They are an excellent vehicle for encouraging the youth's interest in science and technology careers.

Global research infrastructure projects enjoy "flagship" status, largely as a result of their scope and their large scale, and concurrently also command high levels of public interest.

There exists a crucial interface between the global development of science and international development, this interface being most acute in developing countries whose national development imperatives must be strongly informed and underpinned by science, technology and innovation.

5. Evidence-based policy: ASSAf and NACI

In February 2016 South Africa hosted the InterAcademy Partnership (IAP) Conference on Science Advice, which considered the importance of science in policy making across various areas, such as climate change, urbanisation, disasters, deadly viruses, or emergencies that confront society. Scientists have a huge responsibility to ensure that scientific debates are informed by solid scientific evidence, logical argument, reasoning and sound advice. It was argued by some that science advice should be viewed as a component of science diplomacy.

Sir Peter Gluckman, science adviser to the New Zealand government, has been a leading light in spelling out the importance of science advice. His view is that policy is rarely determined by science alone, but policy can be informed by evidence. He gives the example of the New Zealand

government decision to outlaw the inclusion of folic acid in bread as it was said to cause cancer. He thought the science advice was wrong. He said this was indicative of the fact that the science community had failed to properly communicate to the public on the issue.

What I learned from this public engagement is that science informs advice, but it does not make policy. There are different audiences for scientific advice, but the science community tends to focus on offering advice at a national level and not at the local government level. And there are different types of science advice: technical, regulatory, formal, informal, and advice in emergencies.

In South Africa, there are various institutions that play a key role in responding to our scientific advice needs. One of the institutions producing evidence-based advice is the Academy of Sciences of South Africa. It's evidence-based reports address a diverse range of topics - from the role of GMOs in agriculture in Africa to the emerging and little studied threat of drug-resistant tuberculosis, as well as strategies for the development of low-carbon cities or the prevention of a tobacco epidemic in Africa. Another is the the National Advisory Council on Innovation, which is an institution established to provide policy advice to the Minister of Science and Technology and the Cabinet. It is independent of government and works through standing committees and task teams comprising of experts drawn from universities, science councils and business.

In addition, our public research councils such as the Human Sciences Research Council, the Council for Scientific and Industrial Research, the Medical Research Council, and the Agricultural Research Council all contribute to generating scientific advice that may guide policy making.

Evidence-based advice is important to sustaining science-based development in Africa. Consider health. We promote health sciences because we need to improve the quality of life here in Africa. African countries are at the forefront of global scientific discovery, as highlighted by the pioneering work undertaken in South Africa in areas such microbicides to prevent HIV-Aids, as well as drug and vaccine development for malaria and tuberculosis. This is shown by the full participation, including as funding parties and equal partners, by South Africa and other African countries, in the European Developing Countries Clinical Trials Partnership.

6. What should African governments do to achieve the goals of STISA and agenda 2063?

South Africa is one of the champions for the new Science, Technology and Innovation Strategy for Africa (STISA) adopted by African leaders at the July 2014 African Union Assembly. STISA focusses on Africa's science, technology and innovation investment in six socio-economic benefit areas: one, eradicating hunger and ensuring food security in Africa; two, preventing and controlling disease, and ensuring human welfare in Africa; three, improving intra-African communication, through investing in physical and digital infrastructure; four, protecting Africa's natural resources; five, building African communities, addressing aspects such as democratisation, urbanisation and conflict resolution; and six, creating wealth for Africa.

Science is at the heart of the AU's Agenda 2063. Little will come of this plan unless each African country adopts a policy of science-led development and puts an efficient government department in place to pursue it. Only then will our grand plans

be able to leverage private and philanthropic participation - like the Alliance for Accelerating Excellence in Science in Africa (AESA), an initiative of the African Academy of Sciences and the New Partnership for Africa's Development.

Here are four features that I believe are necessary to achieve the STISA goals.

First, universities and researchers need academic freedom and freedom of expression. The output of researchers is valuable in evidence-based decision making on science policy. In South Africa the National Advisory Council on Innovation and the Academy of Sciences play a critical role in preparing independent reports that are key reference points for government and policy makers. The work of science councils impacts on policy in areas such as agriculture health, urban development environmental management and climate change responses. Of course, the advice of science councils is not without controversy. From time to time this means we need to consult broadly to allow the public to comment on emerging policy or the views of scientists. This sometimes makes the interaction between scientists and policy makers tense and challenging.

Second, effective science policy needs international partnerships. Science and innovation in South Africa has benefited immensely from a well crafted and energetic international science diplomacy strategy. Our strategy supports individual researchers, institutions and government in establishing well designed and impactful international partnerships. Such links have led to very productive interdisciplinary research outcomes, and have also allowed policy makers to form associations that have multiplied access

to resources in the form of access to research infrastructure and funding for collaborative teams.

Third, policy makers must provide funding for high level development of graduates and support for both established and emerging researchers. Linked to this is the need for policy makers to have a concrete science agenda with key focus areas clearly articulated to scientists and formally funded by government.

Fourth, and last, evaluation is extremely important. Regular review and the existence of reliable and effective data gathering institutions that report regularly on the system and provide quality data that can be used to reform where necessary. Evaluation criteria must also include a focus on indicators of performance that measure research output.

Many countries in Africa do not have all these features and they also tend to be isolated from international collaboration. We all need to strengthen our efforts at inclusion as we can no longer be satisfied with the inadequate innovation capacity of Africa.

7. Conclusion

Prosperous African nations are those with governments that create the right enabling environment for science and technology to flourish. Determining the best technology policy is relatively straightforward, but having the people ready to take advantage of resource-rich opportunities is the real challenge.

What African governments have to do is to determine where their comparative advantage lies and then to exploit it on a national scale. Renewable energy, mobile phones, and the bio-

economy are sectors that have huge potential.

In South Africa we tried "to pick winners" with an electric car and a small scale nuclear reactor and we failed. We then turned to astronomy and picked a winner in radio astronomy where we had a comparative advantage in knowledge and geography. We succeeded with the SKA.