

1 *Science, Development and Africa*

Africa is the oldest of the continents, the birthplace of civilisations, the storehouse of the earliest remains of humans and possesses the most wonderful works of humans. This is what Gardiner Hubbard wrote about Africa over a century ago in 1889. For ages, Africa has refused to reveal its secrets to the world although explorers had penetrated from every side of the continent (Hubbard, 1889). Africa remains an inadequately explored and studied continent.

A great deal has been written and known about Africa but not much about science from Africa, or what Africa can give to science. Jan Hofmeyr, while serving as the President of the South African Association for the Advancement of Science in 1929, asked questions which are still relevant today: What can Africa give to science? What can science give to Africa (Hofmeyr, 1929a)? One might add, what can science do for the development of the continent? In the words of Mohamed Hassan, who was once the president of the African Academy of Sciences: ‘Science alone cannot save Africa, but Africa without science cannot be saved’ (Hassan, 2001: 1609).

Africa is a fruitful field for experiments and a place of expert scientific knowledge (Worthington, 1938). The continent once had some of the world’s best science departments in its universities.¹ It made its quota of contributions to the solutions of some of the most fundamental problems of science (Worthington, 1938). The great challenge for the world’s scientific community, as Nobel laureate David Gross believes, is to connect Africa to the rest of the international scientific world.² In a way, Gross was recognising the importance and relevance of African science and its significance for the world of science and for its own development.

¹ The universities, among others, include the universities of Lagos (Nigeria), Dar-es-Salaam (Tanzania), Accra (Ghana), and Khartoum (Sudan) (Hassan, 2001).

² Quoted in van den Brink and Snyman, 2007, p. 792.

Greg Mills (2016) in his book, *Why Africa Is Poor*, elaborates on why the continent remains poor. In his view, it is not because its people are poor but because their leaders made that choice. It is poor not because its people do not work hard. Rather, their productivity levels are abysmally low because of poor health, poor skills and inefficient land use. It is poor not because it lacks natural resources. Here, science comes to the forefront with a bigger role to play in the development of Africa.

Science is not the monopoly of a few countries and produced in select locations alone. Its presence is felt everywhere and in every field of human life. Dedijer (1968) estimated that between 15 and 30 of the 120 countries which had less than one-third of the world's population had practically all of its science and had spent more than 95 per cent of its R&D (Research and Development) funds. However, this ratio and proportion has changed in the contemporary world. There has been a global shift in the production of science and in the quantity of research publications and their impact (Radosevic and Yoruk, 2014).

The contribution of countries to world science has been changing. Over the years, there has been a shift in core and peripheral countries. Germany was a centre of world science in the 1930s but the United States expropriated that position in the post-Second World War period (Schott, 1998). China, which is a periphery country, has improved its share of the world science. The rise of China on the horizon of science has been striking, overtaking Japan and Europe in its publication output (The Royal Society, 2011).

Science, Growth and Development

The frontier of world science is moving, although not drastically. The production of science and the purpose for which it is done has been evolving. It is a public good. Science is becoming a part of commerce and market goods (Krishna, 2014). In this evolution, the primary purpose of science is changing from the advancement of knowledge more towards wealth (Krishna, 2014). The relevance of science in development comes at this juncture.

Science is a fascinating endeavour, capable of engaging men and women at their best, and enlarging and enriching the human spirit with discoveries (Ziman, 1984). It has become an integral and indispensable component of human history, progress and development.

Science offers a potential source for social change, capable of revolutionising areas of experience (Barnes, 1972) and contributes towards overcoming the conditions of underdevelopment (Sagasti, 1973). Science and its application through technology transforms the world at a rapid pace (IAC, 2004). The new knowledge that is being produced at an unimaginable rate reconstructs society, and influences the way we think about the world today (IAP, 2016) and the way we lead our lives.

While speaking at the International March for Science, Glenda Gray, the president of the South African Medical Council, said: ‘Investing in research and development is about investing in the citizens of our country. Science changes lives, shifts paradigms of thought and promotes innovative economic progress’ (Pillay, 2017: 3).

With the unprecedented growth in science and technology (S&T), particularly since the Second World War, the relationship between S&T and development has become stronger. In the 1950s and 1960s, the ability of science to deal with human problems generated great levels of optimism (Raina, 1999) and interest in science and development. The growing recognition of the role of S&T has coincided with the Millennium Development Goals as well (Juma and Yee-Cheong, 2005). Science has become a recipe to solve a range of problems of development (Krieger, 2000).

Regardless of the size and wealth of nations, science has evolved into a powerful and influential social institution, sought after by governments, and public and private sectors (Krishna, 2014). As a big global enterprise and a massive human undertaking, science is occurring in more and more locations with millions of researchers and billions of dollars being made available (Moravcsik, 1984; The Royal Society, 2011). There are 8.496 million full-time equivalent (FTE) researchers in the world (UIS, 2016a). The participation of countries in science has been widespread, as science has become a valuable possession to meet their needs (Moravcsik, 1986a). Millions of scientific publications are produced every year, more countries are increasing their participation in the production of science, and the amount of money spent on science is correspondingly increasing across the world. The effects of S&T are more powerful and pervasive than in the past (Rath, 1990). These will continue to increase in future.

Science is part of a whole system. The parts are interdependent. The institutionalisation of science has made it more intimately related to other institutions of society (Merton, 1969). Science maintains its

dominant position as an integral tool for development and economic growth. Science is part of progress, for both individuals and nations alike (Schott, 1993). In his studies, Merton (1978) documented the interrelationship between economy and science. He observed the relation between science and economic needs in seventeenth century England. Socially patterned interests, motivations and behaviour in one sphere of life such as the economy are interdependent with the patterned interests, motivations and behaviour in other institutional spheres such as science (Merton, 1973). This shows the interrelatedness of economy, economic growth, development and science (Merton, 1973). In terms of wealth and technology, as Elmslie and Criss (1999) reported, science has advanced to a superior position relative to other countries, and its societal division of labour extended to all fields.

The interplay between socio-economic and scientific development is now well recognised (Merton, 1939, 1978). Scholars have identified the connections between science and several other components of development and growth (Carter, 1968; Enos, 1995; Nour, 2005, 2012). Advances in S&T are crucial for economic success (Enos, 1995), and S&T development is a key to economic growth, industrial competitiveness, social development and improvement of quality of life (Nour, 2005, 2012).

Science is the main driving force behind industrial and post-industrial societies (Krishna, 2014). At the same time, countries that have not adopted the usefulness of science have suffered economically (Debru, 2000). In the globalised economy, S&T are key drivers of economic growth and development (Carty, 2000; Freudenthal, 2014; Gazni and Ghaseminik, 2019; The Royal Society, 2011; Thulstrup et al., 1996; UNESCO, 2000). S&T are also the primary driving force of innovation, increased productivity, wealth creation and social welfare, and play a significant role in the economic performance of countries (ICSU, 2005; OECD, 2000). Evidence suggests that technological change accounts for an overwhelming share of the increase in production output (Rath, 1990).³ This is obvious from the track record of

³ Nour (2005) quoting *The Second European Report in S&T Indicators 1997* of OECD summarises that the 50 leading S&T countries in the world had long-standing economic growth which is much higher than that of the other 130 countries in the world. The average economic growth of these 50 countries during 1986–94 was three times greater than the rest of the world.

developed countries. Industrialised countries in the past have benefitted from the huge investments they had made in S&T (Nour, 2005, 2012). This is true not only for the developed countries but also for countries such as South Korea, India and Brazil which have all benefitted from their investments in S&T (Wagner et al., 2001).

Economic development requires direct engagement in the generation of knowledge (King, 2004), through which science can be fruitfully exploited to achieve economic growth (Dasgupta and David, 1994). The application and conversion of scientific knowledge into technological products facilitates growth. Indisputably, it is the engine that drives economic growth in developed countries.⁴ Science contributes to significant economic growth and productivity (Wagner et al., 2001). The benefits for economic growth of applying science are evident in many areas: agriculture, industry and medicine (Williams, 1968) are but some of them. Any modest improvements in any field – for example, in healthcare, sanitation, drinking water, food and transport – require scientific capabilities in engineering, technology and medicine (King, 2004).

Science continues to be the single most influential force and will remain so for many more years to come (Lane, 2000). A host of factors contributes to the growth and development of science. Dedijer (1968) speaks about three major ones. First is the presence of a scientific community with its own institutions for training and research and its own scientific tradition. A government apparatus with a tradition in dealing with science is the second one. The last one is those institutions (industrial, agricultural, commercial, educational, medical and others) that have learnt the value of research and are able to make reasonable demands on the scientific community and government.

The growing importance of research institutions in the 1950s and 1960s has made people consider science as an essential tool for productivity and economic growth (Hetman, 1979). The productivity of a population is dependent, more than anything else, on advances in

⁴ In the United States alone, for instance, technology has been responsible for two-thirds of the increase in economic growth (Wandiga, 2000). The per capita growth of the US economy, between 1870 and 1910, was primarily due to improvements in technological and managerial innovations (Colglazier, 1981). At the beginning of the century, the estimated scientific contribution to the Gross Domestic Product (GDP) in developed countries was 10 per cent, which had grown into 40 per cent later in the 1950s, and 60–80 per cent in the 1980s (Yongxiang, 2000).

S&T (Enos, 1995). There is evidence to support the relationship between economic wealth and scientific productivity, although the relationship has not always been positive (Schott, 1991).⁵ The relationship between the stock of knowledge and the flow of wealth, and the relationship between the stock of knowledge and the expenditure on R&D have been well documented (Carter, 1968).

From as recently as the 1960s, there has been a general increase in the interest and awareness of science in developing countries. The 1960s were called the decade of awareness-building that occurred through many channels of conferences, workshops, plans and training (Moravcsik, 1975). While the economic benefits that S&T bring to developing countries are considerable, these are not the only reason or justification for them to focus on S&T (Moravcsik, 1982). Other evolving conditions in countries also play a role.

Science is an integral component of national development. Its role in the development of policies for national development has been emphasised. Even modest improvements in science can have remarkable effects on development, especially in poor countries (Kennedy, 2001). Science can provide the knowledge to make informed decisions (Lubchenco, 2000; Odhiambo, 2000) on policies pertaining to national development. Practically, every decision in any field of national endeavour requires scientific knowledge (Dedijer, 1968). Notions of scientific relevance focus less on the language of national growth but more on research towards finding solutions to challenges (Hackmann and Boulton, 2015). Ultimately, science is meant for the living conditions of people, meeting the developmental needs of society. The bond between S&T and the developmental needs of specific societies must be stronger than ever if the former is to serve humankind.

Developments in S&T have become a yardstick of measurement of modernity as well (Godin, 2005). Several dimensions of S&T can be listed. Moravcsik (1987) cites two of these. The first one is that S&T are crucial ingredients in the efforts to find a remedy for a broad range of immediate and pressing problems pertaining to the economy, health and many other aspects of life. The second one is the task of creating an indigenous capability in S&T which is essential for the

⁵ Schott (1991) provides some specific instances. Japan has relatively little scientific work in relation to its wealth. Arab countries in North Africa and West Asia have the lowest scientific productivity in relation to their economic wealth. But India has the highest scientific productivity in relation to its wealth.

science-technology-production-living style complex, to participate in one of the respected and influential activities of the century, and the exercise of the impact of science for humankind. While S&T alone cannot solve all the complex problems humans face today, those problems cannot be solved without the help of S&T (Lane, 2000).

Increasingly, science leads technology in many areas and is a necessary condition to establishing sustained growth (Lipsey, 2001, 2009). Long-term economic growth and technologies, as Lipsey et al. (2005) argue, transform the entire set of economic, social and political structures of societies. Any technological change requires alterations in the structure of the economy (Lipsey et al., 2005).

One should take into account the way S&T spreads across the world, the levels of progress that have been accomplished in a variegated manner and the benefits those have brought to the well-being of people. But the use and function of science in developing and developed countries are not the same and are debatable (Lomnitz and Salord, 1992). The growing gap between developed and developing countries has also been reflected in a growing distance between countries in terms of S&T (Durant, 2000). Consequently, this gap in the availability and application of S&T is manifested in a range of scenarios, affecting the overall development of economy, society and the countries in general.

Science for African Development

In Africa, science and technological research and development priorities were not always made in line with priority needs (Thisen, 1993). S&T were never thought of as part of the development process in Africa (Forje, 1989). A development option, based on the recognition of scientific knowledge and the potential of Africa, was slow to begin (Worthington, 1938). The national policies of S&T in African countries, by and large, have not been achieved as yet. The integration of S&T in the national development plans of countries is one of the key functions of national S&T policy-making bodies (UNESCO, 1986). The challenge for Africa is to integrate S&T in development (Confraria and Godinho, 2015).

As Edgar Worthington (1952) observed, amidst arguments that there was development for years without any scientific background, the forms of science in Africa have to be closely related to development. Scientists themselves were concerned about the relevance and role of

S&T in society (Rath, 1990). The set of problems evident in Africa requires solutions through research in Africa and by Africans (Dow, 1988). Science has a major role in this, not just for Africa. The 2030 agenda for sustainable development, adopted by the UN in 2015, concedes that the Sustainable Development Goals cannot be achieved without the support of science. Science is critical to meeting the challenge of sustainable development; it lays the foundation for new approaches and technologies that can solve local and global problems (UNESCO, 2015a). Irrespective of the capacity of regions, development in S&T is a challenge for sustainable development (Malcom et al., 2002). Sustainable development can be achieved when there is enough capacity available for the creation and application of S&T in societies.

A principal factor that has been identified as a stumbling block for Africa to achieve economic growth is its shortcomings in S&T (*Current Science*, 2001, cited in Gaillard et al., 2005: 177; Forje, 1989; Gaillard, 2003a; UNESCO, 2000; Wad, 1984). These shortcomings are evident in several forms. There is a deficiency in S&T in African development, which exists at both theoretical and methodological levels (Wad, 1984). In order for Africa to advance, the efficient use of its technical resources is pivotal (World Bank, 1981). The position a country attains in the production of knowledge depends on the degree of technological sophistication it has achieved (Zegeye and Vambe, 2006). They are linked to the scientific capacity of a country. In order for science to advance, both the capacity and the ability of the country to create and absorb science are crucial. Regrettably, the capacity levels for the creation and (or) the absorption of imported S&T are low in underdeveloped countries (Sagasti, 1973). It is also essential to have policies in place that facilitate and encourage science and scientific development. For instance, the cause of underdevelopment in Egypt was inappropriate S&T policies (Zahlan, 1997).

As Wad (1984) points out, the relationship between S&T and socio-economic development has not been well articulated in Africa. NEPAD (2005), in its report, admitted that science, technology and innovation (STI) have not received any serious attention as engines of development in Africa. One needs to know the history and the contemporary state of science in Africa, and its potential for socio-economic development to make sense of the relationship between S&T and development. The continent does not have a long history of doing science, as compared to about 400 years of history for the developed world. In many areas,

science is at its infancy in this part of the world. This study looks into this relationship through the examination of the production of science in Africa.

The idea of science for development was not completely alien to Africa. The vibrant nature of science and science development is becoming more visible in Africa now. In his first presidential speech at the foundation summit of the Organisation of African Unity (OAU) in 1963, Kwame Nkrumah emphasised the possibility of S&T for the development of Africa (AU, 2014a).⁶ Prior to the Lagos Plan of Action, the Monrovia Declaration in Liberia in (1979) was announced. The Monrovia Declaration adopted the resolution to put S&T in the service of development by reinforcing autonomous capacity for countries. By the decade 1970–9, several African countries were becoming conscious of the role of S&T for their development (OAU, 1981).

The indispensability of S&T is in laying the foundations for development and in solving fundamental problems (Barré and Papon, 1993). The emphasis of Africa should be primarily on making use of science for its developmental needs. Science affords the opportunity for such development (Merton, 1942), and social and economic development work hand in hand with scientific development (Chatelin et al., 1997).

The series of deliberate efforts under the auspices of UN agencies had an impact on increasing awareness about the role of S&T in development in the postcolonial period (Forje, 1989).⁷ These were pursued by a number of missions dispatched to African countries to assist them with the formulation of national science policies (Forje, 1989).⁸ Efforts were made to establish institutions for S&T. Despite these, African countries lacked the necessary scientific and technological capacity, resources and skills and were dependent on foreign countries (OAU, 1981). This was not the case at the time of independence. Science development was not a pressing issue or concern for Africa then

⁶ The OAU became the African Union (AU) in 2002.

⁷ Some of these include the UN conference on the application of S&T to the development of less-developed countries (Geneva in 1963), the international conference on the organisation of research and training in Africa (Lagos in 1964), the symposium on science policy and research administration in Africa (Yaoundé, 1967), the UN conference on S&T for development (Vienna in 1979), and the second conference of ministers of African member states responsible for the application of S&T to development (Arusha in 1987) (Forje, 1989).

⁸ Forje (1989) records that there were twenty-seven such missions to thirty-two countries and organisations during 1964–87.

(Forje, 1989), and this remained the case for a long time. It was easier to acquire technology from developed countries rather than developing its own research capacity (Forje, 1989). This approach underestimated the part of science in development (Forje, 1989). Perhaps this was the mistake many African countries made on achieving their independence.

There has been a growing interest in S&T for development in Africa. Science and the production of scientific knowledge in Africa have become the interest and concern of scholars and policymakers (Sooryamoorthy, 2018). The role of S&T in economic growth and development for Africa is now being recognised (Wakhungu, 2001). S&T are appreciated as the cornerstones for progress in Africa through economic growth (ESTA, 2006). There is a consensus in African countries that scientific research is a requirement for the creation of long-term sustainable development (Confraria and Godinho, 2015). From this point of view, science is recognised to be crucial for Africa, to address its numerous developmental problems. A heightened interest in the relevance of S&T is obvious, particularly since the Lagos Plan of Action (ESTA, 2006; Odhiambo, 1967; Toivanen and Ponomarev, 2011; Wad, 1984). This was not the case in the early 1930s and the results of scientific research did not influence African development at all (Worthington, 1938).

The general consensus among political leaders, administrators and scientists in Africa is that accelerated science development is useful in dealing with social and economic problems (Odhiambo, 1967). The summit of the OAU had called for its member countries to ensure the development of an adequate S&T base and appropriate application of science in spearheading development in various fields (OAU, 1981). The OAU also developed a programme of action for S&T at its Lagos meeting. The plan emphasised the need for national policies on S&T to be integrated into the national development plan (OAU, 1981). In 2007, Africa declared it to be the year of S&T for Africa and urged countries to set the target of 1 per cent of the GDP (Gross Domestic Product) for R&D. Even earlier, at the first NEPAD ministerial conference on S&T held in November 2003 in Johannesburg, ministers made a commitment to increase funding for R&D to 1 per cent of the GDP. The Science, Technology and Innovation Strategy for Africa 2024 (STISA-24) also encourages the member countries of the African Union to allocate at least 1 per cent of their GDP to R&D. This is yet to be uniformly realised in Africa.