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Research Paper

The roles of science and technology in national development

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Science and Technology hold the key to the progress and development of any nation. Technology plays a Fundamental role in wealth creation, improvement of the quality of life and real economic growth and transformation in any society. It is on recognition of the above that this paper examines the concept of technology emphasizing the relationship between Science and technology, the key role of science and technology in societal Development as well as the role/importance of science and technology in National Development. The paper went further to critically identify and examine the roles of science and technology in different Segments of life such as poverty alleviation, Health, Agriculture, affordable energy, water supply, environmental management, economic growth, rural development and Education. The paper thus observes that the gap between rich and poor countries can largely be attributed to the differences in Technology and the difficulty in their Application. It recommends policy options for reaping benefits from science and technology in Nigeria which include among others that the educational system shall emphasize science at all levels and re-orient the entire society towards scientific thinking in order to develop new technologies and adapt existing ones to improve the societal well being. Finally, considering the roles of science and technology in national development, it is imperative to stimulate demand for technology from both private and public sectors.

Key Word: Science, Technology, Roles, National Development, Policy options

INTRODUCTION

Technology simply put is a means of harnessing and exploiting our understanding of nature for our own benefit. It is an application of knowledge for practical purpose. It is used to improve human condition, natural environment or to carry out other socio-economic activities. It could also be defined or refers to all processes dealing with materials and their end products. One important attribute of technology is that it does not just happen; it is developed and learned whether in the farm of manual skills or as an applied science. It is the systematic application of collective human rationality to the solution of human problems through the assertion of control over nature; technology is the engine of growth. Technology can be traced historically to the beginning of time to be man's quest to improve his way and quality of life. According to Egbogah (2012), Technology is the total and complete application of man's knowledge, skills, tools and materials. It is the use of scientific knowledge to develop and produce goods and services useful to man. It is practical problem-solving enterprise, which is propelled by scientific discovery or by societal needs.

The components of technology that must be present for meaningful benefits according to Obibuku (1983) include knowledge (i.e. science, education, skills and know-

how), organization (i.e. institutional, aspects of methods of production, co- ordination, relationship to the environment) and techniques (i.e. ways of doing things, production process, the combination of human and material resources).

Technology therefore can be broadly classified into two major categories namely:

(a) Material Technology- where knowledge is embedded into technological products such as tools, equipment, agro-chemicals, improved plant varieties or hybrids, improved breeds of animals and vaccines.

(b) Knowledge-Based Technology- such as technical knowledge, management skills and other processes which are needed to successfully produce products or grow crops. A technology may be appropriate or inappropriate depending on the nature and capable of use of such technology. An appropriate technology is a form of technology which makes use of available resources in a given economic environment. It concentrates on tools and techniques which are carefully tailored to their needs. It is a technology that is accessible, manageable, transferable and within the reach of the people (Obibuaku, 1983). According to Canadian Hunger foundation in Obibuaku (1983), appropriate technology is the technology which is most suitably adapted to the conditions of a given situation. The foundation maintained that for a technology to be appropriate, it must show the following features:

(i) Simple and easy to understand
(ii) Manageable
(iii) Inexpensive
(iv) Flexible
(v) Adaptable to changing needs
(vi) Technically feasible
(vii) Locally serviceable
(viii) Employment generation potential
(ix) Infrastructural compatible and compatible with the people's cultural practices.

Therefore, a technology well suited to one environment may not transfer well to another very different environment.

Technology and Science

Science is a branch of knowledge that is concerned with the observation and classification of facts and formulation of general truth. Science suggests ideas and technology operationalizes them. Science clarifies and justifies how an objective may be achieved. The "how" is translated into practical realization and from here, technology takes over and complements science (Williams, 1998). This therefore shows that there is a symbolic relationship between science and technology. Science which is a systematic search for truth provides the basis for technology. Without technology, science becomes impotent, and without science, technology does not exist. However, it is the technology, the application of techniques and not science that leads to increase in production. In the past, science and technology constituted distinct traditions, maintaining separate identity paths of process and activities. But around the 19th century, there was a development of closer relationship between the two. The narrowing of that gap of separate identities culminated in the birth of the concept of science and technology.

The Key Role of Science and Technology in Societal Development

Science and technology hold the key to the present and future development of Nigeria or any other country for that matter. Technology plays a fundamental role in wealth creation, improvement of the quality of life and real economic growth and transformation in any society. Egbogah (2012) maintained that the sooner Nigeria realizes that her escape from poverty is predicated on her investment in science and technology education, the better for her. Animalu (2001) in Egbogah (2012) explained that there is a technological power vacuum in Nigeria waiting to be filled by which ever geo-political zone that cares to mobilize its people through dedicated and selfless services. Essentially, technology is the primary engine of economic growth. It is the key and fundamental requirement for value addition to raw materials and people. It provides the key to unlocking any country's potential in terms of decreasing over-head costs associated with out sourcing and creating employment opportunities. Science and technology education will not only prepare the Youths of Nigeria and indeed any other nation, for fulfilling career prospects, but also train their minds to address social problems with scientific mind. Youths equipped with science and technology education are also endowed with high employment opportunities. Many developed and advanced countries did progress much because of their heavy investments on science and technology. Examples: The United Kingdom and France benefited immensely from the industrial revolution in the 19th century. Similarly, the United States emerged from an agrarian economy in the 19th century into an industrial superpower in the 20th century. More recently, Taiwan and Korea have exploited advances in silicon microelectronics from the early 1960s. China and India have emerged as industrial leaders in manufacturing and information technology respectively. Malaysia has also followed in the footsteps of these later Asian successes. It is necessary to emphasize here that in recorded achievements all these countries invested heavily in people, factories and infrastructure that provided the foundation for today's industries. These successes were all based on carefully designed roadmaps of plans and strategies. Unfortunately, however in many if not all the

non-development or yet to develop countries, technology is seen or viewed as a consumable- item, and not something that can be produced or created. Analysis of technologically advanced economics shows that at each level of the economy, science and technology provide the engine for economic growth. For example, in the case of primary products, application of science and technology significantly increase the yield from agricultural production and mineral beneficiation. Similarly, new and existing industries do stimulate economic growth at the intermediate level, while the overall volume of activity at the tertiary level is amplified by increased use of science and technology associated with information technology and improved distribution/marketing networks. Therefore, the need for countries with the intention to grow, to invest significantly in science and technology cannot be overemphasized. This is achieved by developing the talent, the human capacity required to compete in a globally competitive world of today.

Role/Importance of Science and Technology in National Development

Science and technology have been central in the progress and development of virtually all the nations of the world. It has contributed immensely in all sector of the economy. Science and technology are intimately connected with development because; they have historical record of bringing advances that have led to healthier, longer, wealthier and more productive lives and they are key ingredients to solutions to the most serious poverty alleviation and economic development challenges that we currently face and are likely to face in the future. The many ways in which science and technology impact poverty alleviation across various sectors and economic growth merit attention.

Role of Science and Technology in Poverty Alleviation

Science and technology have been central in the progress made to date in the fight against poverty and in stimulating economic growth. Advances in science and technology are, in many ways, the ultimate Global Public Good: once discovered, their benefits can be extended to additional users at little or no marginal costs. In most basic and critical areas of human need, science and technology have made possible significant progress to date, and they hold the best prospects for continued progress, particularly with respect to agriculture, health, energy, water, and environmental concerns.

Role of Science and Technology in Health

Advances in scientific knowledge and its application have helped slow the trend of high fertility, high mortality and led to increasingly better health for many people world over.Nonetheless, vector and water borne diseases, Aids, inadequate pre-natal and maternal/child create a tremendous burden in the developing countries. Nigeria and indeed countries will be unable to correctly identify public health needs and choose cost-effective package of health service if they lack science and technology capacity. Ill-health is both a cause and a consequence of poverty. Over the past century, science and technology provided the basis for the largest ever aggregate improvements in human health. Certain scourge diseases have been eliminated, (e.g., smallpox) whiles the morbidity and mortality associated with everyday health-related events like childbirth and routine infectious disease have declines sharply. Indoor air pollution, dysentery, water-borne disease (e.g. cholera), vector-borne disease (e.g., malaria, dengue, etc.) and AIDS account for millions of deaths annually and are hitting hardest the countries that are least prepared and can least afford to deal with them. Some of these issues can be addressed using current knowledge, (e.g., dysentery) while still others require scientific breakthroughs in science and technology (e.g., AIDS, malaria and even Ebola).

Role of Science and Technology in Agriculture

Advance in science and technology have facilitated higher yields, greater efficiency and greater nutritional content in the worlds food supply. Food production, however, must double in the coming decades to meet rising demand and meet the challenges entailed in inter alia improving resistance to drought, pests, salinity and temperature extremes, raising the nutritional content and reducing post-harvest loss all in an environmentally and socially sustainable manner. At the same time, the regulatory challenges of assuring safety in food production and consumption will increase exponentially. Although, the necessary technology for increasing the agricultural output is available in many developing countries including Nigeria but certain requisites must be met. They according to Williams (1998) include:

(i) The will to advance economically.
(ii) Opportunity and organization to use the technology.
(iii) Elimination of political, social and economic obstacles to development as was inherited from early colonial history.
(iv) Ability first, to incorporate the technology into overall development, and then to continue using it.

In the domain of food security, advances in science and technology provided the foundation for Green Revolution, and have allowed food prices to remain at historical lows for the past decades. Improved knowledge of plant biology and breeding techniques led to better seeds and cultivation practices that drastically increased yields.

Rapid advances in the understanding of plant biology and related areas (especially via genomics) hold hope for solutions to problems as varied as increased productivity, nutritional content of food, food as a carrier of vaccines, soil/land degradation, post-harvest loss, and drought and pest resistance.

Role of Science and Technology in Affordable Energy

Access to affordable energy is essential for people currently living without electricity and is a pre-requisite for economic growth. Further advancement and application of research is needed to find new environmentally and socially sustainable technology that can meet the energy needs of developing countries (Watson *et al.,* 2003). Other problem, such as the needs of people who live without access to adequate fresh water, or whose health and livelihood are endangered by environmental degradation call for development of new technologies (along with appropriate policy frame works)to mitigate these problems and their effects on poor people. Timely local adoption often requires significant indigenous technological capacity. Modern clean, renewable energy technologies (e.g., solar, wind, modern biomass) need to be developed further and there needs to be an increase in the efficiency and sustainability of energy use in transportation, industry, and housing.

Role of Science and Technology in Water Supply

Water is another vital but scarce resources for which, in the absence of technological innovation, current and projected use patterns can only lead to severe crises. Today, about, 1.3 billion people lack access to an adequate supply of safe- water, two billion people do not have access to adequate sanitation, and water pollution causes millions of preventable deaths each year, especially among children. Water pollution is expected to continue to degrade freshwater and marine ecosystems, with a significant loss of biodiversity. The challenge is to leverage new technologies to provide an adequate supply of "safe" water in urban and rural areas to all users in a growing-wealthier population: households, agriculture and industrial sectors (e.g., inexpensive desalination).

Role of Science and Technology in Environmental Management

Environmental degradation at the local, regional and global scale adversely affects the livelihoods, health and vulnerability of poor people. Local issues include indoor and outdoor air pollution and water pollution, regional issues include acid deposition, and global issues include climate change, stratospheric ozone depletion, and loss of biological diversity, land degradation and desertification. These changes in the environment can adversely affect the incomes of poor people who depend on natural resources for their livelihood. These changes may also adversely affect human health through air and water pollution, an increase in the exposure to vector-borne disease such as malaria and dengue, and an increase the vulnerability of poor people to extreme weather phenomena (e.g., floods and droughts) and sea level rise due to climate changes. Hence, environment degradation threatens poverty alleviation and long-term sustainable development. The key challenge is to recognize that local, regional global environmental issues are inextricable linked and affect sustainable development. Therefore, there are synergetic opportunities to develop more effective response options to these environmental issues that enhance benefits, reduce cost and more sustainably meet human needs. The capacity of countries to adapt and mitigate can be enhanced when environmental policies are integrated with national development policies.

Role of Science and Technology in Economic Growth and Rural Development

Science and technology are tragically important to economic opportunity and growth. For many years policymakers have suspected a close link between economic growth and productive investment in science and technology and now mounting evidence supports this, in three principle ways (Watson *et al*., 2003).

First, since the industrial revolution, rich (developed) countries have had the most science and technology capacity and have grown fastest. From 1870 to the present, scientifically and technologically-advanced countries have become increasing wealthy and their rates of growth have not diminished as this occurred. Second, returns to rural and development have been shown to be consistently positive and high in countries where science and technology are properly established. In such case, there is always a correlation between innovation and growth.

Role of Science and Technology in Education

No economy has ever becomes developed with this skew in their system of education and training for national manpower supply and/or human capital development. The utter disregard for science and technology education as an instrument of development has caused incalculable damage to our corporate existence. The problems of mismanaged economy, mass unemployment, collapse of health and educational services, insecurity, inflation, collapsed infrastructure, etc can all be traced to the inadequate attention paid to science and technology in

Nigeria. It is the lack of science and technology initiative by Nigerians that has led people to turn their energy to the lust for power, greed and self destruction. Sadly enough, every Nigerian finds every other person guilty as charged, except himself or herself.
Government's policy on education has among other issues emphasized but not driven the following objectives:

(i) The training of the mind and the acquisition of appropriate skills, abilities and competencies-both mental and physical as equipment for the individual to live and contribute to the development of the society.
(ii) Ensuring that all schools are properly equipped to promote sound and effective teaching, and in particular, that suitable textbooks and libraries are provided for school.

Secondary education should be six-year duration and be given in two stages, a junior secondary school stage and a senior secondary school stage. The junior secondary school (3-year duration) will be both prevocational and academic. It would be free. The senior secondary school would be for those *able* and willing to have a complete six-year secondary education.
(iii) A greater proportion of education expenditure would be devoted to science and technology and a greater attention paid to the development of scientific orientation.

However, it is common knowledge that three decades after these objectives were set out to improve the standard of education in the country, not only have none of the objectives been realized, but also the standard of education has fallen far below what it was before (Egbogah, 2012).

Conclusion

No doubt, science and technology hold the key to the present and future development of any nation including Nigeria. Technology is achieved through a combination of knowledge, methods, tools and skills. This four-element definition of technology offers the details and clarity required for technology enhancement planning that must necessarily include knowledge and skills upgrade (training) and acquisition of human elements (knowledge and skills) and the tangible elements (methods and tools) of technology form the basis for our thinking and working processes. We must ensure adequate development of man power in science and technology to guarantee the efficient utilization of abundant natural resources and reduce the drain on our treasury and independence on outside sources for industrialization. The nation should be technologically self-reliant in the production of capital and consumer goods and raw materials. The educational system shall emphasize science at all levels and re-orient the entire society towards scientific thinking in order to develop new technologies and adapt existing ones to improve societal well being and security. Technology-based developments can occur only with concerted efforts to revitalize education, develop personnel and create integrated industries that will involve close collaboration between government, industry and academia. Considering the roles of science and technology in national development, it become important to stimulate demand for technology from private sector, renew emphasis on the creation of linkages between firms and knowledge institutions, reform enabling environments for better use of knowledge, setting priority and evaluation right, promoting transparency, objectivity, selectivity and international best practices in science and technology funding, increasing access to ICTs and Government as a consumer of knowledge.

Recommendations

Some middle-income countries such as Nigeria have managed to create pockets of science and technology capacity that at least partially serve their economic and social ambitions. However, they appear to have been serve deficits of science and technology capacity. Improvement on the role of science and technology depends on the adoption of appropriate policies and activities on at least four areas: human resources development, demand for knowledge in the private sector, public support of science and technology and access to information and communication technologies (ICT).

(a) Policies for science and technology in human resources development aim to provide science education at the basic secondary and tertiary level, prepare young people enter a diverse labor force that requires various levels of science and technology sophistication and encourage the conduct of research and advanced training.
(b) "Implicit" policies for science and technology create an enabling environment that stimulates demand for knowledge in the private sector through, inter alia, a stable macroeconomic environment. Appropriate climates for trade and investment, credit policies, and adequate intellectual property rights regime. "Explicit" policies for science and technology in the private sector aim to further break down barriers to the use of knowledge. These policies may include support for firm-based training to encourage technology deepening, increase industry-academia linkage and public private partnerships, establish protection for indigenous knowledge provide tax incentives for firm engaged in rural development, and stimulate "clusters" of knowledge-based industries.
(c) Policies for public support of science and technology must address the various aspect of the public role in the

national innovation system, including: setting priorities for funding and research, providing financing, instituting open, transparent peer-review selection processes establishing governance regulatory and management mechanism, incorporating the results of research in public policy decision, and monitoring and evaluating the system.

(d) Policies for information and communication technology should seek to maximize the access to and flow of knowledge by, inter alia, extending access of available ICT to a wider range of user, improving the regulatory framework to facilitate a conductive environment for ICT growth, and providing training and education to facilities broader use of ICT.

Authors' declaration

We declare that this study is an original research by our research team and we agree to publish it in the journal.

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