STRATEGIES FOR ECONOMIC EMPOWERMENT THROUGH ENDOGENOUS SCIENCE AND TECHNOLOGY

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Abstract

Sustained and effective development of endogenous science and technology (ES and T) will make a tremendous impact on the nations and on the achievement of the Millennium Development Goals (MDGs) as agreed at the Millennium Summit in Brazil in 2000. Increasing levels of understanding and learning of science, engineering and technology will facilitate the blending of endogenous and exogenous science and technology to meet our needs and priorities such as the objectives outlined by New Partnership for African Development (NEPAD) and the policy thrustS and Targets of the various sectors of the economy by NEEDS. There are different outputs of S and T and special features of technological learning that people have to be aware. Nigeria has an impressive number of R and Ds and IDCs such as PRODA, FIIRO, NOTAP, RMRDC and NASRDA. The works of FIIRO in S and T has been acclaimed as masterpiece. Research and Development institutions (R and Ds) have important role to play in the design and implementation of strategies already put together by National Economic Empowerment and Development Strategy (NEEDS). World bodies such as UNDP, UNESCO, World Bank, and South Commission have been making contributions and support to the developing countries to progress in achieving economic development through science and technology (S and T). They have capacities for technical, financial, scientific, strategic, et cetera advice. Limited capacities and awareness are restricting nations from enjoying their services. These bodies suggest strategies for S and T development, give conditions for benefiting from their assistance; and fund publications to disseminate knowledge. ES and T offer many challenges and opportunities to the developing nations who may have to set up different specialised types of institutions to facilitate the learning.

Introduction

Endogenous Science and Technology have been used for survival, economic growth and development of a nation times without number. They present challenges and opportunities to countries. However, the developing nations including Nigerian have a lackadaisical approach to the learning of ES and T. Also, some countries lack the prerequisite knowledge, skills and determination to adapt ES and T for meeting the present needs and priorities. Consequently, the developing countries in Africa, Asia and Latin America, particularly, in the sub-Saharan Africa have economic problems confronting them such as low literacy rate, unemployment, hunger, poverty, corruption, brain-drain and environmental hazards. ES and T offers ample opportunity for improving on quality of our life. They require that we should acquire a good knowledge of S and T, and positive attitude to learn them.

This paper examines the issues pertinent to the topic 'Strategies for Economic Empowerment through Endogenous Science and Technology' for effective harnessing of the opportunities that ES and T offer for sustainable empowerment of people and for national economic development. It examines issues such as demanding increasing levels of learning S and T to blend endogenous and exogenous S and T, National Economic Empowerment and Development Strategy (NEEDS), and ES and T, World organizations contributions, strategies, and challenges and opportunities.

At 46 years' old, what has Nigeria done for the economic empowerment through endogenous science and technology?

ES and T are considered essential resources to stimulate economic growth and development and to meet daily needs and priorities in both the developed and developing economies. Prior to the era of European colonialism

and the scramble for Africa, African countries met the challenges of life such as hunger, environmental hazards, farming, hunting, tooling, fishing, sailing, and manufacturing products through ES and T.

The rapid population growth, urbanization, western life style; and other socio-economic factors are creating new challenges. Today, the resources of nations are been re-classified. Formerly, land, water and food were in abundance, but presently, these vital natural resources are scarce in developing countries. Clean environment, information, scientific knowledge and `new' and `old' technological skills are sine qua non for economic growth, development and survival of nations.

According to Padelford *et al* (1976), technological status of a nation can be at least partly measured by some indicators. One such indicator is the proportion of the population of a nation engaged in agriculture. He concludes that if this is high, it can normally be assumed that agricultural technology is backward or that industrial technology has not created any alternative to marginal subsistence farming or both. Currently in Nigeria, agriculture accounts for above seventy per cent (70%) of the workforce. Although Nigeria is rich in natural and human resources, 7 of 10 Nigerians live on less than $1 a day. (NEEDS, 2004).

Steps taken

Specifically, the Federal Government of Nigeria (FGN) has been active in the following areas:

Funding and setting up R and Ds. Below are some of the institutions:

21 research and development institutes under the supervision of the department of science and technology on February 25, 1985.

1. Institute for Agriculture Research, Ahmadu Bello University, Samaru, Zaria.
2. National Horticultural Research Institue, Ibadan.
3. Nigerian Institute for Oil Palm Research, Benin City.
4. Leather Research Institute of Nigeria, Zaria.
5. National Root Crops Research Institute, Umudike, Umuahia.
6. Rubber Research Institute of Nigeria, Iyanomo, Benin City.
7. Projects Development Institute (PRODA), Independent Layout, Enugu.
8. National Institute of Medical Research, Yaba, Lagos State.
9. Kainji Lake Research Instituted, New Bussa, Niger State.
10. Cocoa Research Institute of Nigeria, Onigambari, Ibadan.
11. Forestry Research Institute of Nigeria, Ibadan.
12. Institute of Agriculture Research and Training, Obafemi Awolowo University, Moore Plantation, Ile-Ife.
13. Lake Chad Research Institute, Maiduguri.
14. National Animal Production Instituted, Shika, Zaria.
15. National Cereals Research Institute, Badeggi, Bida .
16. Nigerian Building and Road Research Institue, Ikoyi, Lagos.
17. Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos.
18. Nigerian Institue for Trypanosomiasis Research, Kaduna.
19. Agricultural Extension Research Liaison Services, ABU, Samaru, Zaria.
20. Nigerian stored Products Research Institute, Yaba, Lagos.
21. Federal Institute of Industrial Research Oshodi (FIIRO), Lagos.

Source: Federal Ministry of Education, Science and Technology: Brochure on Science and Technology Department, 1985.

NB. Each of these R and Ds has specified functions to carry out in the economy.

The other prominent R and Ds include:

1. Raw Materials Research and Development Council (RMRDC), Abuja.
2. National Office for Technology Acquisition and Promotion (NOTAP), Abuja.
3. National Space Research and Development Agency (NASRDA), Abuja.
4. Sheda Science and Technology Complex, Abuja.

Recently, FIIRO has been credited to the design and development of over seventy (70) technologies, which are specially fabricated to utilize local available raw materials (*Businessday*, 2004).

Nigeria has also established the following institutions:

- Industrial Development Centres (IDCs) to provide technical training and advisory services. IDCs were established at Owerri, Zaria, Osogbo, Maiduguri, Abeokuta, Sokoto, Benin City, Uyo, Bauchi, Akure, Ilorin, Port Harcourt, Kano and Ikorodu.
- Nigeria Communication Commission (NCC).
- The Federal Ministry of Science and Technology to design and implement policies and strategies and regulate S and T.
- Specialized science and technology-based institutions such as Yaba College of Technology, Yaba; Kaduna Polytechnic, Kaduna; The Polytechnic, Ibadan and other Polytechnics.
- Nigeria has been promoting conferences and seminars on S and T.
- Perhaps, one can say that Nigeria has done remarkably well in these areas. But, Nigeria still has a lot of work to do in other sectors such as agriculture, manufacturing, education, agro-allied, energy, science, engineering and technology to improve the quality of life of people.

Needs for increasing level of learning

There is need to blend the endogenous and exogenous S and T to achieve MDGs in the Sub-Saharan Africa in line with the objectives outlined by African Heads of State in the New Partnership for Africa's Development (NEPAD). The Pan-African initiative is based on the analysis of a study titled: 'Can Africa claim the 21st century?' In other to realize these aims, we need to build bridges between the indigenous and modern knowledge on S and T.

Definitions of science and technology

Leikind and Miles (1970) define S and T as follows:

- Science represents a body of objective knowledge about the universe and man's place in it and constitutes an activity, the means by which scientific knowledge is increased
- Technology is a body of knowledge and devices by which man masters his natural environment. The modern world is largely the fruit of the union between science and technology consummated just about a century ago.
- Leikind and Miles concludes that in technology, one can buy what one wants up to a set maximum, but, in science, one can only buy more or less what nature will give in quantity and in quality. They suggest that in both science and technology we should concentrate our attention on research. Also, they consider science and technology as natural resources, both in themselves and as tools for improving other material and human resources.

Obviously, we need both endogenous (self-generated) and exogenous (originating from external aid) science and technology to face the present and future challenges.

Different outputs of science and technology:

Science	Technology
1. Publication (Intellectual Property).	Invention (patent).
2. Supranational (Involving more than one country).	National.
3. Follows dictate of nature.	Property of Civilization.
4. Knowledge from research to be published openly.	Product of labour to be bought and sold.
5. Scientists use technology that they have grown up with.	Technologist use the science they have learned.

Science and technology are loosely connected systems with very different types of people involved for very different motivations and purposes and even trainings.

Source: Marwin, J.C. and Joel D. Goldhar (eds). *The Science of Managing Organized Technology. Vol. 1.* (NY: Gordon and Breach, 1970), pp. 21-49.

Two challenging questions

How can an organization implement its strategic plan with actions that are appropriate to the present-future rather than ones that are catching up with the past-present? How can Nigeria make S and T an essential part of the culture of the various ethnic groups in the country?

Features of technological learning

Technology is closely related to science and to engineering and deals with tools and techniques for carrying out specified functions. Features of technological learning facilitate the understanding of technological phenomena. Lall (2002) postulates the following features for technological learning in developing countries:

- People sometimes have hazy knowledge of the technologies they are using.
- Learning process faces risk, uncertainty and cost.
- Learning process is highly technology-specific, since technologies differ in their learning requirements. For instance, process technologies (like chemicals) are more embodied than engineering technologies (machinery or automobiles), and demand different (often less) effort.
- Different technologies have different spillover effects and potential for further technological advance. Specialization in technologies with more technological potential and spillovers has greater dynamic benefits than specialization in technologies with limited potential.
- Capacity-building occurs at all levels. Innovation is at the end of the spectrum of technological activity; it does not exhaust it. However, research and development (R and D) becomes important as more complex technologies are used.
- Technological development can take place to different depths:
  - Operational Capability (know how).
  - An understanding of the principles of the technology (know-why).
  - The deeper the levels of technological capabilities aimed at, the higher the cost, risk and duration involved.
- Technological learning is rife with externalities and linkages. It is driven by links with supplies of inputs or capital goods, competitors, customers, consultants and Technology suppliers. There are also important interactions with firms in unrelated industries, technology, institutes, extension services, universities, associations and Training institutions.
- Technological interactions occur within country and with other countries. Imported technology is generally the most important initial input into learning in developing countries. Since technologies change constantly, access to foreign sources of innovation is vital to continued technological progress. Technology import is not, however, a substitute for indigenous capability development. Similarly, not all models of technology import are equally conducive to indigenous learning.

Needs and capacity building for ES and T

The development of ES and T will affect the Nigeria economy and quality of life of the people in many ways. It will affect: agriculture, welfare, health, employment, education, employment, manufacturing and traditional medicine.

Specifically, ES and T will help to:

- Offer farmers improved irrigation, machinery, and crop varieties.
- Boost agricultural productivity.
- Support Small and Medium size enterprises (SMEs).
- Check the flow of irrigation from rural to urban areas.
- Improve education.
- Improve health system .
- Improve Infrastructure: roads and electric power.
- Support Industries.
- Stimulate rapid industrial growth and efficient exploitation of resources (NEEDS, 2004).

Manufacturing sector

NEEDS (2004) says: "Although the manufacturing sector (including micro, small, and medium-size enterprises has the potential to create wealth and empowerment, the sector has stagnated in Nigeria. . ."

Constraints

NEEDS lists the following three constraints as facing the manufacturing sector:

- Lack of demand for the products and services of small and medium-size enterprises (SMEs).
- Lack of political will to implement local content and technical know-how policies.
- Lack of engineering capacity to translate science research results into finished goods and maintain existing machinery, low level of entrepreneurial capacity, complete lack of institutional monitoring and technological support, and the paucity of trained artisan skills.

NEEDS: Federal Government Strategies

Federal Government of Nigeria has declared to:

- Remove infrastructure constraints on SMEs and expedite action on establishing *clusters* and *industrial* parks.
- Provide appropriate institutional support for SMEs.
- Provide targeted incentives (such as tax deductibility) for science, technology, and research and development spending.
- Coordinate and facilitate the implementation of effective competitive industrialization strategies in collaboration with relevant agencies.
- Implement a government procurement policy that supports locally produced goods and services, especially of SMEs.
- Promote the production of good-quality goods and services in Nigeria to facilitate a competitive export-oriented manufacturing sector.
- Systematic and operational constraints that impede the competitive capacities of large manufacturing companies.

ES and T, if properly focused, will be indispensable resources to implement the strategies.

NEEDS: Policy thrust

Specific policy thrusts of *NEEDS* under manufacturing sector include to:

- Establish a structured and efficient micro-small and medium-size enterprise sector to enhance sustainable economic development, generate employment, and create wealth.
- Facilitate the development of an industrial sector that is internationally competitive and as well as give priority to the processing of Nigeria's abundant resource endowments into intermediate raw materials or finished goods for local consumption and export.
- Develop science and engineering infrastructure: well-trained technical and managerial personnel, physical plants, tools, spare parts, materials, and other inputs needed to operate efficiently and profitably.

Challenges to information and communication technologies (ICTS)

- Lack of local manufacturing or maintenance of information and telecommunication equipment and the lack of local (computer) software development capacity.
- India is currently one of the world leaders in the development of computer software. This is a classical example of an application of endogenous science (knowledge) to empower the people.
- Inadequate human capacity and indigenous technical know-how.

I have no doubt in our mind that *NEEDS* identifies areas that ES and T will be needed. It presents some policy thrusts and strategies. These are supposed to guide us in the implementation of feasible strategies for economic empowerment through ES and T. *NEEDS* also indirectly or directly present us with constraints, challenges and opportunities for ES and T. Despite the givens of the *NEEDS*, we still have to explore other ways and means to

ensure successful design and implementation of the strategies proffered by *NEEDS* and The Conference delegates.

Suggested strategies for science and technology development

Besides the strategies already in place for the *NEEDS* scheme for economic empowerment and development, the United Nations System and the South Commission design strategies for S and T development in developing countries.

The report of the South Commission (1990) offers the following strategies:

- Countries must be able to pick the technologies most appropriate to their circumstances and, in many cases, to adapt them to make them appropriate. But in the long run, the South (developing countries) must also acquire an ability to develop by itself technologies suited to its need.
- The experience of the developed world and the needs of the South suggest that at least a doubling of the existing allocations for R and D in developing countries is required. This would bring their level close to the 1 per cent of the Gross National Product (GNP) recommended by United Nation Educational, Scientific and Cultural Organization (UNESCO). Countries that have succeeded in achieving technological break through are those which have consistently productively invested not less than two per cent of Gross Domestic Product (GDP) in R and D (*Businessday*, 2003). The investment of Nigeria in R and D is estimated to be 0.01% per cent of GDP.
- In regard to human capabilities, the goal should be at least to triple the number of scientists and engineers. This will require strengthening the educational system and, especially, raising the status of scientists in the society.
- The existence of a scientific infrastructure, the availability of equipment, access to foreign literature, international contracts, and adequate remuneration and incentives are prerequisites for creative work and productive research, and for the development and application of science and technology.
- A strong foundation in basic sciences backed by an effective system of research is vital for the growth of applied science and technology.
- Producing trained personnel on whose advice the developing countries can rely is also necessary if they are to be able to make the right choice of imported technologies to adapt, absorb, and diffuse them in the production system, to ensure their efficient use, and in due course to develop a national capability to generate new technologies.
- Science teaching has to be given emphasis throughout the educational system.
- There is an urgent need to reform the present systems of incentives and rewards so as to ensure that both at the secondary and university level an increasing proportion of students will opt for technical and professional courses.
- The report states that the first area to be developed will usually be classical low technology, followed by applied sciences provided that some expertises in basic sciences are already available. The last area to be developed will generally be science-based high technology.
- In conclusion, the critical factors for success are the recognition of the close interconnections among the different areas of science and technology, basic and applied science, low and high technologies; and the realization of advances in all of them.
- UNESCO (2006) suggests promoting the active participation of women in science and technology, and ensuring that the need of gender equality and women's empowerment is pursued and fully reflected in the design of national science and technology policies for sustainable development.
- In keeping with the World Conference on Science, contemporary science should be used to evaluate, learn from, complement and apply for economic and health benefit, the traditional knowledge systems that already exist in any developing country.
- Morris-Suzuki (1994) reports that Japan has a sympathetic-tradition of local support for the diffusion of technical innovations through trade associations and local government. Promote Cooperation among universities, polytechnics and industries through partnerships as well as through networks of laboratories and universities, and promote research on measures to improve networking with scientists abroad.

Contributions of the world bodies

The world bodies such as UNESCO, UNDP, ILO, The World Bank, WTO, have been of much assistance to the developing countries both technically and financially. In order to reduce the gap in knowledge between the developing and developed countries, they have been very helpful through their advisory services.

Synthesis of the 2002 Gambia-United Nations (UN) country team development forum

Gambia is a member of the Economic Community of West African States (ECOWAS). It is a small country in terms of size and population. United Nations has been very helpful to the country. According to the Synthesis of the 2002 The Gambia-UN Team Country Development Forum Proceedings Report, developing countries, which have achieved rapid economic growth, share the following various common characteristics:

- Endogenous) capacity building, and tiered human resource development;
- Introduction of advanced technologies from abroad; and
- Stimulation of research and development through institutional support.

Ingredients

The synthesis identified the following ingredients as requirements to build up technological capacities:

- Research and development policies for science and technology;
- Manpower planning exercises that gives priority to science and technology;
- Education in science and technology;
- Large pool of scientifically and technically trained personnel from the educational system; and
- Active involvement of the private sector in all of the above, activities.

According to the forum proceeding report: 'development of scientific and technological capacities requires sustained, long term commitment to quality education and scientific training from primary to tertiary level.'

The World Bank

The World Bank (2004) has periodical publication on indigenous knowledge initiative in the Sub-Saharan Africa. The publication is a collection of successful community experiences that helps to promote the development of indigenous knowledge (IK). The President of the World Bank, James D. Wolfensohn, describes the publication: 'to be a valuable source in improving our understanding of how communities empower themselves to manage their own development in the larger context of Globalization.'

The publication contains articles on the potentials, uses, self-developed technologies, institutional constraints in promoting indigenous knowledge.

Conditions for UN system assistance

United Nations system has a lot of assistance packages for the developing countries to harness the skills and creativity of the people for economic empowerment. Bouyard and Hernnandez (2001) says that the following fundamental pre-requisites must be fulfilled for the United Nations system and other external inputs to be effective in building up endogenous capacity in any recipient country. They include, for example:

- Political will.
- Clear-sighted national policies and strategies.
- Relatively high literacy rate.
- High performing educational and research institutions.
- Societal consensus and stability.
- Adequate budgets.
- Other socio-economic factors likely to create the environment in which science and technology can flourish.

It is highly debatable whether ES and T have made meaningful contributions made to the people living in the developing countries of World. The low level of development in the countries Sub-Saharan Africa has

continuously been a source of concern to the World bodies. Since 1950s, a lot of both technical and financial assistance has been provided to most of the African countries to enable them to catch up with the rate of development in the developed countries. The results of the aids have neither been impressive nor encouraging. The existing situation has become unacceptable to the countries and the relevant world bodies.

Challenges and opportunties

Nigerians have to accept the challenges of our time and capitalized on the opportunity of using ES and T. The economic development activities are dynamic and create unlimited challenges and opportunities. Some of them include:

- Emerging new technologies such as information and communication technologies (ICTs). They are playing crucial role in facilitating rapid economic growth and globalization. ICTs are continuously transforming our societies by facilitating access to information, research, manufacturing, communication and other economic activities. We must thoroughly explore the opportunities currently offered by ICTs.
- Nigeria has large bodies of natural water. Traditional fishing farming has not supplied the required fish products for food. Osarenkhoe (2002) suggests that the application of modern technology coupled with vaccination will improve growth in intensive fish farming system. Consequently, fish farmers will earn higher incomes and make available more fish products (protein) to the society at affordable price. The resultant effect could be more employment for the unemployed people.

Basic industries

Basic industries such as machinery, forging, foundry and metal casting are essential for the Nigerian economy which depends entirely on the importation of nearly all the machineries (new and used) and spare parts she needs. At this critical stage of developing, Nigerian should endeavour to produce most of the simple machineries and spare parts that are needed in the various sectors of the economy. In the advanced countries, such as USA, Canada, Spain, Germany, these basic industries have developed into large and sophisticated industries as seen today.

Recommendation and conclusion

I recommend that:

- The government (Federal, State and Local) must be actively and adequately involved in the design and implementation of effective strategies for successful economic empowerment through ES & T. Hence, the following agencies must be established and adequately funded and equipped. They are:
  1. Research and development centers.
  2. Technical training centers.
  3. Technical guidance centers.
  4. Technical and managerial diagnosis centers.
  5. Science and technology information centers.

Once the strategies are successfully carried out, ES and T may become the quintessential tools of economic empowerment of our people.

Nigeria should use modern technologies and self-generated ones simultaneously to empower the people. Everyday, researchers are trying to find solutions to our problems. The government should pay adequate attention to the needs of the R and Ds, particularly, human resource, money and facilities.

References

A peep into FIIRO Archives, April 14, 2004, *Businessday*, April 14 2004, (*Small Business Journal*), p. 15.

Assessing Nigeria's Technical Readiness for Globalization, *Businessday*, February 13, 2003, p. 36.

Bouyard-Agha, Faith, Homero L. Hernandez United Nations System Support for Science and Technology in Latin America and the Caribbean 2001. [On line]. Available from: http.www.unjiu.org/data/reports/2001/en200/-2.pd/ (Accessed 20 September 2006).

World Bank, 2004. Indigenous knowledge: Local Pathways to Global Development – Marking Five Years of the World Bank Indigenous Knowledge for Development Program Geneva.

Lall, The Features of Technological Learning in Developing Countries, *Businessday*, July 29, 2004, (*Small Business Journal*), pp. 11B.

Leikind, Morris C., Wyndham Miles, The Nature of Science and Technology. In: Cetron, Marwin J., Goldhar, Joel. D. (eds). *The Science of Managing Organized Technology Vol. 1* (NY: Gordon and Breach, 1970), pp. 46-49.

Morris-Suzuki, T. *The technological transformation of Japan: From the seventeenth to the twenty-first century* (Cambridge: Cambridge University Press, 1994), p. 16.

National Economic Empowerment and Development Strategy NEEDS (Abuja, Nigeria: National Planning Commission, 2004), pp. 1-80.

Osarenkhoe, Victor, Modern fish farming and the application of anti-oxidants, vitamins, caretenoids and feed additive. *Thisday*, June 30, 2002.

Padelford, Norman J., George, A. Lincoln, Lee D.O. Levey. *The Dynamics of International Politics, 3rd Edition*, (NY: Macmillan, 1976), p. 164.

The Challenge to the South: The Report of the South Commission. New York: Oxford University Press, 1990, pp. 109-113.

UNESCO Regional Strategy: A synthesis discussion (2002) [On line]. Available from: http://www.ukhap.nic.in/ap%20medium%20strategy.doc (Accessed 16 September 2006).

UNESCO. 2006. Science and Technology Policies for Sustainable Development Programme [On line]. Available from: http://www.UNESCO.org/science/psd/programme.shmil. (Accessed 16 September 2006).

Acronyms and abbreviations

ES and T	Endogenous Science and Technology.
MGs	Millennium Development Goals.
UNDP	United Nations Development Programme.
UNESCO	United Nations Educational, Scientific and Cultural Organization.
WB	World Bank.
S and T	Science and Technology.
NEPAD	New Partnership for African Development.
NEEDS	National Economic Empowerment and Development Strategy (NEEDS.
R and D	Research and Development Institution.
R and Ds	Research and Development Institutions.
IDCs	Industrial Development Centres.
FIIRO	Federal Institute of Industrial Research.
NOTAP	National Office for Technology Acquisition and Promotion.
RMRDC	Raw Materials Research and Development Council.
NASRDA	National Space Research and Development Agency.
PRODA	Projects Development Institute.
FGN	Federal Government of Nigeria.
GDP	Gross Domestic Product.
GNP	Gross National Product.
ILO	International Labour Organisation.
UN	United Nations.
IK	Indigenous Knowledge.
WTO	World Trade Organisation.
ICTs	Information and Communication Technologies.