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Developing Indigenous Technology for Harnessing Local Natural Resources in Nigeria: The Place of Technical Vocational Education and Training

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ABSTRACT

Nigeria is endowed with a huge and vast array of natural resources such as petroleum and natural gas, solid minerals, agro materials, forest and wild life species and extensive water bodies. With the abundance of natural resources in Nigeria, one would expect the country to rank among the richest and developed nations but the irony is the country is hosting the third largest number of poor people in the world after China and India. This is a clear indication that great nations are not made by the abundance of resources inherent in them, rather by the availability of the pool of knowledge adequately applied in delivering goods, processes and services. The country lacks the knowledge (human potential) that can translate its local natural resources to economic wealth. The country spends a huge amount of money importing back finished products of its local resources that were exported, due to inability to process them for utility. If this trend is not checked, the future is not secured. It therefore becomes very necessary to develop/enhance the country's indigenous technology for proper harnessing of the local natural resources. This will reduce waste and ensure sustainable future of the country; because 'he that knows not diamond will certainly use it as a pebble to hunt birds'. It is the view of this paper that enhancing indigenous technology will create vast opportunity and potentials to adequately harness the local resource in a manner that will sustain the future. Also the paper is of the view that Technical, Vocational Education and Training (TVET) has the master key to unlock the door to indigenous technology.

Keywords: *Indigenous Technology, Natural Resources, Developing, Technical Vocational Education and Training (TVET), Technology Transfer*

1. INTRODUCTION

Of the total world mineral resources, Africa mines 90% of the diamond marketed, 81% of cobalt, 62% of platinum, 70% of gold, 50% of magnesium and chromium, and 30% of copper. Africa also produces 66% of world cocoa, 66% of sisal, 95% of groundnut and 25% of coffee beans and cotton. There are rich reserves of coal, oil and iron ore (United Nation Document cited by Chukwujekwu, 2005). According to the United Nation Document, despite the abundant natural resources in Africa, Africa contributes only 2% of the total industrial output of the world's market economies. Although this statistics may have changed, but does not disprove the fact that Africa contributes far beyond expectation in the world's industrial output.

With the abundant resources, Africa countries should rank amongst the richest and most developed nations. Unfortunately, possession of abundant natural resources does not determine the greatness of a nation. In today's globalising knowledge economy, the major determinant of greatness is the available pool of knowledge, talent and creativity adequately applied in delivering goods, processes and services. Mogbo (2000) noted that there are potentially great nations endowed with abundant natural resources, but are underdeveloped, yet some nations like Japan and Israel are potentially poor in natural resource, but are developed. The potential great but underdeveloped countries are regular suppliers of raw materials to the poor but developed nations; who add values to the resources and resupply them at higher cost. Thus the economies of the underdeveloped countries are manipulated, controlled and determined by the developed nations.

Nigeria can be counted as one of the countries richly endowed with natural raw materials. Nigeria's raw materials can be attested to be healthy, abundant and supporting multiple use. They are capable of providing an enviable quality of life for citizens and visitors if properly harnessed and utilized. They can attract and sustain business and tourism that translate into economic wealth.

However, formal Governor of Central Bank of Nigeria (CBN), Sanusi Lamido noted that Nigeria was one of the 50 richest countries globally in the 70s but now one of the 25 poorest countries in the world (Daily Independent, 2013; Information Nigeria, 2013). Nigeria, the ninth largest producer and sixth largest exporter of crude oil, is still hosting the third largest number of poor people in the world after China and India (Ehinomen & Adeleke, 2012). In the same vein, the World Bank President, Jim Yong Kim claimed that two-thirds of the world's extreme poor are concentrated in just five countries – India, China, Nigeria, Bangladesh, and the Democratic Republic of Congo (9jalife, 2014). It is difficult to imagine that poverty in Nigeria is in the mist of plenty.

No gainsaying Nigeria lack the productive human capital to tap its abundant resources and translate such to economic wealth. There is therefore great need to build up Nigeria's indigenous technology that will enhance healthy harnessing and utilization of the natural resources such that the future is sustained. Thus, the paper examines available natural

resources in Nigeria, how and why they should be harness with indigenous technology and the place of technical vocational education and training, TVET in developing indigenous technology.

Availability of Natural Resources in Nigeria

Nigeria is endowed with a huge and vast array of natural resources. The Nigerian economy is heavily dependent on the oil sector which according to International Monetary Fund – IMF, accounts for over 95% of exports earnings and about 40% of government revenue (Energy Information Administration – EIA, 2011). National Bureau of statistics also acknowledged that petroleum contributes as high as 78% of GDP and up to 90% of Nigeria's total annual revenue and foreign exchange earnings (Ehinomen & Adeleke, 2012). Nigeria has been estimated to produce about 2.9 million barrels of oil per day (EIA, 2011).

There are abundance of natural gas, coal, and renewable energy resources that could be used for domestic electricity generation. The country holds the largest natural gas reserves in Africa and the ninth in the world (EIA, 2012). Nigeria has a total area of 923,768km^2, of which 910,768km^2 is land and 13000km^2 is water. Approximately 33% (300,550km^2) of the land is arable, 3.1% (28,235km^2) is under permanent crop, 44% is under permanent pasture, 12% is under forest and woodland and 0.3% (2,820km^2) is under irrigation (Osaghae, 2009, Obioh & Fagbenle, 2009).

Biomass resources in the country include agricultural crops, wood, charcoal, grasses, and shrubs, residues and wastes (agricultural, forestry, municipal and industrial) and aquatic biomass (Agbro & Ogie, 2012). Research has revealed that bio energy reserve/potential of Nigeria stood at: fuel wood – 13071,464 hectares, animal waste – 61 million tonnes per year, crop residue 83 million tonnes per year (Agba, Ushie, Abam, Agba & Okoro, 2010). Nigeria is the largest producer of cassava in the world and has the largest capacity for oil palm plantation, which serves as a great source of bio diesel (Abiodum cited in Agbro & Ogie, 2012).

There are numerous agro materials and solid minerals in Nigeria. Nigeria contributes significantly in the world's export of agro materials as cocoa, rubber, cashew nuts/kernels etc. Other agro materials in abundance are cereals, cassava, yam, tomatoes, onions, palm, ginger, gum Arabic, and sesame etc. Raw Material Research and Development Council – RMRDC (2000) reported that Nigeria is endowed with a variety of solid minerals much of which is yet to be exploited. Profile of some of these materials is shown in table 1.

Table 1: Profile of some solid Minerals in Nigeria

Solid Minerals	Quantity (in Tonnes)	Location
Talc	Over 40 million	Niger, Osun, Kogi, Ogun & Kaduna
Gypsum	Over one billion	All over Nigeria
Iron ore	Over three billion	Kogi, Enugu, Niger & FCT
Lead/Zinc	10 million (estimated)	Over eight States (not mentioned)
Bentonite	700 million	Many states
Barite	Over 7.5 million	Taraba & Bauchi
Gold	Not mentioned	Southern Western Nigeria
Bitumen	42 billion	Not mentioned
Coal	Nearly 3 billion indicated resource & over 600 million proven reserves	Not mentioned
Rock salt	1.5 million	Benue
Spring salt	---------	Plateau & Ebonyi
Gemstones	----------	
Kaolin	3 billion	----------

Source: derived from data provided by RMRDC 2000

Great nations are not made by the abundant of raw materials deposited in them, rather by their ability to utilize the available materials and even those of other nations. These resources make no sense if the people have no capacity to identify them and converted them to economic wealth. It is obvious that if you do not know diamond, when you come across it, you will use it as a pebble to throw at birds.

Nature abhors waste and so every material on earth is useful. Man can only say a material is useless when he has not found the means of converting it to something useful. Author Richard Dawkins rightly said: "Nature is a miserly accountant, grudging the pennies, watching the clock, punishing the smallest extravagance." (Orakpo, 2011). Dr Henry Boyo, Senior Lecturer and Head of Hardware Development Laboratory, University of Lagos said that for Nigeria to move forward, it needs its own indigenous technology, tailored to meet its peculiar needs just as Japan did (Orakpo, 2011).

Indigenous Technology

The word indigenous simply means native or local. It could be used to refer to something that originates within a locality and is unique to the locality. Technology on the other hand can be referred to the art and science of applying knowledge to meet man's needs. Putting the two words together, indigenous technology can be defined as locally developed art and science that is unique to a given culture or society, which is applied to meet man's need. Eionet (2012) defined it as the technology employed by native inhabitants of a country and which constitutes an important part of its cultural heritage and should therefore be protected against exploitation by industrialized countries. World Bank (2013) acknowledged that indigenous knowledge is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management and a host of other activities in rural communities. It is part of the lives of the

rural poor; their livelihood depends almost entirely on specific skills and knowledge essential for survival.

Harnessing Local Natural Resource with Indigenous Technology: Benefits to Nigeria

Specialization in the production and export of raw material is detrimental to long-term growth prospects of the less developed nations. Specialization in export production leads to distortion or disarticulation of the domestic economy, thus preventing balance growth. A hyper-developed export sector is responsive to the demands of the world market, rather than to internal developmental needs. This seems to be particularly true of raw material production which has very limited up chain or down chain effects on the rest of the economy. Consequently exports revenue rise or fall in response to the world market but did not generate a long term growth process with the larger domestic economy.

Contribution of the oil and gas sector to GDP growth (14%) is relatively low compare to investment in the sector (Arogie, 2013). A key reason for the huge difference between the contribution of the oil and gas sector to Government earnings and its contribution to GDP is the fact that most of the spending in that sector is on imported goods/services. The average direct cost of producing a barrel of crude oil in Africa stands at about $45.32 (Arogie, 2013). This is largely due to low Nigeria content in the industry. Nigerian content refers to the quantum of Nigerian human and material resources utilized in transforming Nigerian natural resources to economic wealth in a sustainable manner; and thereby developing indigenous capacity. Most of the work values in the sector are done abroad. Arogie (2013) noted that it has been estimated that about 90% of the expenditure in the oil and gas industry is paid to non-resident companies. In reality therefore, only a minute portion of the amount is available for the development of our economy. This has led to dearth of jobs, skill development, capacity building/utilization and lack of sustained national development. Mr. Harry Okolo, formal president Institute of Chartered Chemists of Nigeria, noted that Nigeria loses about a trillion naira annually to import between 80 – 90 per cent industrial raw materials. Okolo maintained that the problem was not the non-availability of raw materials locally, but the inability of Nigeria to transform available natural resources to utilizable forms (Business Day, 2013). Prof. Peter Onwualu, Director RMRDC, supported that Nigeria is expending foreign exchange to import raw materials and products that can be sourced locally, because of lack of awareness (SME, 2013).

Domestication of a significant portion of the economy derivatives from oil and gas industry will transform the sector into the economic engine for job creation and national growth by developing in-country capacity and indigenous capabilities. Thus, a greater portion of the work will be done in Nigeria with active participation of all sectors of the economy. Ultimately, Nigeria will be positioned as the hub for service delivery within the West African Sub-region and beyond. It will also promote value addition in Nigeria through the utilization of local raw materials, products and services in order to stimulate growth of indigenous capacity.

Presently Nigeria is crowded with many educated unemployed; whereas there are enormous potential opportunities in harnessing the abundant natural resources. Approximately, 30% of recorded Nigerian raw cashew nuts (valued about $12 million USD) are exported to major processing countries, such as India, Brazil and Vietnam, for further value added processing (Chenomic, 2003). Prof. Peter Onwualu affirmed that within 25 years, the development of Nigeria's raw materials will save it over two trillion naira in foreign exchange, and create over two million jobs in the area of raw material production, processing, distribution and final procession of goods and services (News Agency of Nigeria, 2013; SME, 2013). For instance, crops like mango, guava, oranges, tomatoes, vegetables, onions, and cashew, etc. are available in plenty during harvest season. There is a good demand for processed finished food of these crops in the international market. If food processing units are established, which are labour intensive, it will argument employment opportunities. Likewise the abundant mineral resources all over Nigeria, if exploited locally, will transform into economic wealth.

A popular quote by Falton Anderson said "the Glory of God is to conceal a thing; the glory of the king is to search it out". Another quote by Philip Emeagwali said "those who create new knowledge are producing wealth while those who consume it are producing poverty" (Balogun & Aletor, 2008). It is obvious that knowledge is wealth. If Nigeria cannot create its technology and continue to consume the technological products of other developed countries, then it is bound to remain poor and underdeveloped; and the sustainability of its future will be endangered. EIA (2011) observed that in 2010, Nigeria consumed approximately 280,000 billion barrels of oil per day. The four refineries in the country with combined capacity of about 450,000 billion barrels per day could not meet the demand due to poor maintenance, theft and fire hazard. In fact the country imported about 85% of its fuel needs. Again, lack of oil field infrastructure to harness associated natural gas, cost Nigeria $2.5 billion USD per year in lost revenue for gas flaring (EIA, 2011).

Rapid global change is putting many indigenous technologies to threat of extinction. Technologies that cannot adapt quickly to changes or meet new challenges adequately are often dropped. The common practice of going for foreign advance technologies, that promise short-term gains without being able to sustain them, often dismisses the potential of local experiences and practices. The tragedy of the loss of indigenous technology is most obvious to those who have developed it and make living through it (World Bank, 2013). This can explain why local groups seeking share of the oil wealth often attack oil infrastructure and staff; involving in oil bunkering and pipeline vandalism. This causes loss of production, pollution and shutdown of companies. The pollution further causes loss in arable land and decreasing fish stocks. These hoodlums as the government may call them, have developed local technologies to refine the crude oil. Instead of supporting to enhance the technology, they are hunted as criminals. Being displaced of their source of livelihood by advanced technologies and no provision to get them employed in gainful acts, they continue to cause havoc.

Developing and Enhancing Indigenous Technology

Technology is the product of creativity and innovation. Man in his ingenuity is in constant research to proffer solution to environmental challenges and lead a better life. The result of which culminates to technology through minor or incremental technical change. Indigenous technology development is enhanced through technology import and transfer. Onwualu (2008) observing the technological capacity development of India, identified three levels of indigenous technology development process:

- Basic level – ability to operate and maintain a new production plant base on imported technology.
- Intermediate level – ability to duplicate and adapt the design for an imported plant and techniques elsewhere in the country or abroad.
- Advance level – capability to undertake new designs and develop new production systems and components

Technology transfer includes transplanting factory base production system; as was the case of the early industrialization of Japan in 1870s. The government established factories were equipped and employed foreign engineers and skilled workers at high salaries to instruct Japanese workers in the manufacturing technologies and techniques necessary for most up-to-date factory production (Masayuki, 2004). The trend of cotton industry in Japan is a good demonstration of technology transfer. The first government cotton spinning factory was equipped with only one British spinning machine with capacity of 2,000 spindles. Later, many cotton spinning companies with tens of thousands of spindles were established as a great boom of investment in cotton spinning. The result was that the English and Indian imported yarns were drove out of the domestic market in Japan. Even Japan started exporting the stuff to foreign countries like Korea and China.

Technology import is good, because along it comes technology know-how and modernization that competition from abroad ensures. This is the classic justification for import liberalization. All countries import technology, but different modes of import have different impacts on local technological development. In a developing country, heavy reliance on foreign direct investment may become a substitute for domestic effort. Hence building a strong domestic technological base entails a selective curtailment of foreign direct investment entry.

The complexity of technology should not be a justification for importing it, if the importing entity is not capable of adopting, adapting and diffusing the technology. In the early 1970s, the now defunct Eastern Regional Government of Nigeria established Premier cashew processing plant at Oghe Enugu. This factory was built to process roughly 350MT raw nuts. This plant utilized Japanese technology (fully automated with all equipment imported from Japan). This turnkey, project required reliable infrastructure (electricity), highly skilled labour and working capital; all of which were unavailable. The plant has been idle and up for sale since the early 1990s (Chemonics, 2003).

However, the Jof Ideal Family cashew processing plant in Owo, Ondo State started exporting cashew kernel in late 1980s using labour intensive Indian technology. The owner hired an experienced Indian cashew production manager to start up the 2,500MT per year raw nut capacity plant. In less than two years, the Nigerian owned and managed Jof Ideal was fully operational, exporting cashew kernels to U.K. Since then, other processors have successfully copied Jof's strategy. Jof trained managers and employees are highly sought after by new processors (Chemonics, 2003).

Technologies have to be developed through a gradual learning process, resulting from purposive effort to assimilate, adapt and modify the new technology. Thus they have to be developed in close collaboration with the prospective users through a process in which the user can take significant control over the direction of the project and equipment procedure. Technologies are rarely perfect when they come "off-the-shell" (Romijn, 2000). Several rounds of forwards and backward feedback of information between developers and users are needed to improve and adapt them in iterative fashion. Many of these efforts take the form of improvements on the shop floor rather than formal R&D. Making a mechanical lathe available to a woodworking shop or introducing an improved cooking stove model for low-income household to local metal workers who are to manufacture it, obviously constitute developmentally beneficial policy interventions in their own right. Rather than viewing the supply of these deliverables as final project objectives. The process of their introduction into a local business community should also be seen as a means through which small producers can master new technical and organizational skills and knowledge. This will strengthen their capacity to introduce other products and process innovations on their own initiative at a later stage.

Innovation and technical change are sustained not within firm alone, but between networks of firms. The rate of technical change in an industry may well depend on dynamic linkages between firms. However, firms have more knowledge of their technology less about similar technologies of other firms and very little about dissimilar alternatives even in the same industry. Gaining mastery of new technology requires skills, efforts and investments by the receiving entity. The extent of mastery is uncertain and varies according to these inputs. Nelson and Winter (1997) explained that technology accumulation strongly depends on the recipients ability to manipulate the given technology. Technology is tacit and the buyer can never hope to obtain all the required information form a blue print manual or training. The buyer must make certain effort to master the technology and adapts it to environmental conditions. This in turn brings about minor incremental technical change. It also confers idiosyncratic characteristic on individual plants and set firms on specific evolution trajectories.

Foreign knowledge does not necessarily mean modern technology, it includes also indigenous technology developed and applied under similar condition elsewhere. These techniques are likely to be adopted faster and applied more successfully. To foster such a transfer, a sound understanding of indigenous knowledge is needed. This requires means for capture and validation, as well as the eventual exchange, transfer and dissemination of indigenous knowledge (World

Bank, 2013); hence the place of Technical, Vocational Education and Training.

The Place of Technical Vocational Education and Training – TVET

The technological capability of a nation determines the efficiency at which the nation harnesses her natural resources or utilizes resources acquired from other nations. Abundance of natural resources means nothing if not transformed to generate wealth. Transforming them to optimum economic wealth requires knowledge and skills, particularly indigenous knowledge. Developing and adapting technology indigenously for harnessing local natural resources is more sustainable than importing finished products. TVET plays a vital role in developing the required knowledge and skill (quality human capital) that stimulates growth. TVET has remained one of the effective means through which advance technology can be achieved.

TVET refer to those aspects of educational processes involving, in addition to general education, the study of technologies and related sciences, as well as the acquisition of practical skills, attitudes, understandings and knowledge relating to occupations in various sectors of economic and social life (Federal Republic of Nigeria-FRN, 2004). TVET develops individuals' capability to design, produce and use technology products and systems, as well as, to assess the appropriateness of technological action. TVET constitutes the arteries that supply life sustaining blood to technological development. TVET trainees are capable to bring about technical innovations/revolutions and initiate a process of sustainable technological development.

The crops of scientific and technical personnel produced by TVET are capable of developing the national technical capacity of their countries via:

- Having an in-depth understanding of technology
- Utilizing technological products/systems
- Adopting, adapting and renovating foreign technologies
- Diffusing technology through the national economy
- Researching and inventing technology
- Developing indigenous technology
- Instigating technological revolution
- Deepening industrial structure

2. CONCLUSION

It is one thing to have potentials and another to develop the potentials. That a nation is richly endowed with natural raw materials is not a guarantee that the nation is rich especially when the resources are underutilized or mismanaged. Africa is richly blessed with raw materials yet most African countries are still poor, particularly Nigeria. This is due mainly to their inability to develop technologies that can tap their resources.

It is no more in doubt that the greatness of a nation is closely linked to its technological capabilities. These have enable them to harness their natural resources and those of other nations. However, acquiring technical knowledge is a cumulative process so national technological competence cannot be changed rapidly. Blue prints accompanying turnkey projects are no more than road maps; the buyers must travel the road alone by their efforts. Technical knowledge is largely tacit and specific, so it can only be mastered by painstaking learning. TVET holds the master key to achieving this mastery.

3. RECOMMENDATIONS

Government, NGOs and/or wealthy Nigerians should:

1. Develop and improve TVET programs to respond to the economic needs of the country.
2. Linked TVET to industries to fast track process management and value addition to Nigeria vast natural resources
3. Control foreign investment and enhance Nigerian local content.
4. Support and encourage small scale producers and entrepreneurs in medium size plants
5. Support technological innovations and patronize local manufactured products
6. Develop standards and protection against sub-standard equipment
7. Develop import substation measure on parts or equipment and machinery that can be made locally
8. Maintain consistency in government policies to allow for long-term planning and investment
9. Discourage the scourge of multiple taxation by the 3-tiers of government
10. Diversify interest and investment to other natural resources, rather than concentrating only on crude oil.

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