Industrial Engineering Letters
ISSN 2224-6096 (Paper) ISSN 2225-0581 (online)
Vol.4, No.7, 2014

Promoting Industrialization Through Commercialization of Innovation in Nigeria.

Ogunwusi, A.A. and H.D Ibrahim

Raw Materials Research and Developmrnt Council, Plot 17, Aguiyi Ironsi Street, Maitama Abuja

Abstract

In recent decades, innovation has become the focus of economic research as a long term factor of economic development. Continuous innovation improves a firm's performance by increasing demand for its products and services and to reduce cost. In Nigeria while the Science, Technology and Innovation system is massive and expansive and contains about 125 universities, 125 poly-techniques, 98 colleges of education and over 300 institutions composed of research institutes, innovation agencies, policy implementation departments, multinational companies and large pool of skilled labour, including a sizeable Diaspora, the economy is still technologically weak with a very high national poverty incidence. These have not resulted in significant industrial activities and national economic prosperity. Thus, Nigeria currently stands at 66 out of 73 countries ranked on the basis of innovation activities. One of the major problems limiting contribution of innovation to industrial development in Nigeria is the low level of fund available for innovation activities. While government is the sole sponsor of R&D activities in Nigeria, the funding level is abysmally low at about 0.11% of the GDP. In addition, there is lack of trust by the private sector on innovation from public research institutes and the universities as a result of inadequate infrastructural facilities. Also little or no interaction exists among major actors in the innovation system leading to high level of duplication. To obviate some of the problems and set stakeholders in the Science Technology and Innovation system on the right path, government should encourage linkage between the public RIs and universities, increase funding of R&D innvovation from the meagre 0.1% to a minimum of 1% of GDP in line with UNESCO reccommendations and upgrade the facilities at the public research institutes and the universities. It has become germain that public RIs and universities contribute at least 30% of their running costs through patenting and commercialization of research results. This will ecourage entreprenureship development among research scientists in addition to fostering linkage between the public research institites, universities and the private sector.

Keywords: innovation, commercialization, industrialization, research and development

1.0 Introduction

In recent decades, innovation has become the focus of economic research as a key long term factor of economic development (UN, 2012). The interest in innovation and its role in economic development started after the Second World War and has continued till date (OECD, 2005). The results of studies have increasingly emphasized the link between innovation, underlying research and entrepreneurial effort aimed at commercializing the results of Research and Development (R&D) (UN, 2012). Without innovation, most enterprises will remain at marginal level. This makes innovation an important aspect of business strategy for products development or improved efficiency (UN, 2012).

The flow of technology and information among people, enterprises and institutions is the key to the innovative process. It promotes interactions between operatives required to turn an idea into a process, product or service in the market. In order words, innovation takes place not only when technologies are developed, but also in business practice, workplace organization and companies external relations. According to the United Nation (2012), innovation is associated with uncertainty over the outcome of innovation activities, involves investment that may yield potential returns in the future and it is subject to spillovers as creative innovation are fully appropriated by the inventing firms. Innovation involves utilization of new knowledge or a new use or a combination of existing knowledge. It aims at improving the firms performance by gaining a competitive advantage by shifting the demand curve for the firms products (UN,2012).

Continuous innovation implies accompanying flow of decision making in strategy, organization, finance, marketing and location of operations alongside activities that relates to research, design and operation (Teece, 2007). Firms innovate in order to improve performance by increasing demand for its products and services and

to reduce costs. At the heart of continuous innovation process is the commercialization of R&D results. This can be defined as the process of turning an invention into a product or service which could be sold in the market, thereby, providing profits for the company. Continous commercialization nurtures the process of innovation and this is pivotal to sustained economic growth. Fostering the commercialization of R&D results has become especially important in many emerging market economies. This has made it mandatory for stakeholders in the innovation process such as research institutions and producers as well as regulatory agencies to establish links and collaborate in order to foster the process of innovation and commercialization. In view of this, economic activities globally are becoming more and more knowledge intensive leading to growth of high technology industries and increasing demand for highly skilled people. This has neceesitated increased investment in knowledge, such as research and development, education and training and innovation which are germain to economic growth (OECD, 1997).

In Nigeria, while the national Science, Technology and Innovation (STI) system is expansive and massive, it has not resulted in significant expansion in industrial activities and national economic prosperity. This is because of little or no interaction among the actors, weak infrastructure and insignificant fund appropriation, thereby, limiting national economic, technological and industrial growth and development. In view of the low level of industrialisation in Nigeria, the country has institutionalized a vision 20/2020 to position it as one of the top 20 global economies by the year 2020. Thus, Nigeria aims at significantly increasing the manufacturing local content and linkages with other sectors of the economy with the specific objective of enhancing global competitiveness of locally produced goods and services. In achieving this role, there is need to intensify effort on developing science and technology infrastructure, and thereby expand the potentials of innovation in the industrialization process. From assessment by experts, Nigeria's journey towards achievement of its vision 20/2020 initiative will be constrained by a number of factors. Among these are the country's low technological capabilities, low level of infrastructure to modulate innovation capacity or ability to create or apply new knowledge to solve practical solutions (, 2008). According to Oyelara-Oyeyinka (2008), Nigeria currently stands at 66st position out of 73 countries in an assessment that ranked nations according to innovation capacity as shown in Table 1. This paper examined the problems militating against sucessful deployment of innovation through commmercialisation of research results to promote national industrial development aspirations. It make recommendations based on global best practices to foster increased commercialisation of innovation activities locally.

2.0 Research and Development in Nigeria

Research is a means of demonstrating one's ability and capability in solving an identified problem and it is an important pointer to the national technological capability. One of the major roles of research is in breeding industrialization which brings about jobs and wealth creation, arrests social menace and assists in curbing rural-urban migration.

The history of Research and Development in Nigeria can be traced to the establishment of a National Council for Scientific and Industrial Research (NCSIR) in 1964, following an international conference on the organization of Research and Training in Africa (FMST, 2010). According to Yusuf (2012), the Council's mandate was narrow and as such had structural weakness which made its function ineffective and inefficient. As a result, with assistance of UNESCO experts, four research Councils were established after the Civil war in 1970. These were:

1. Agricultural Research Council of Nigeria (ARCN)
2. Medical Research Council of Nigeria (MRCN)
3. Natural Sciences Research Council of Nigeria (NSRCN)
4. Industrial Research Council of Nigeria (IRCN)

In 1986, the first National Policy on Science and Technology (S&T) was launched (Yusuf *et al*, 2012). The policy identified that S&T-related activities in the country had been carried out without well defined national direction. The public universities, research institutes and research outfits in private sector companies are expected to be drivers of research and development and home grown technologies. Also, R&D are expected to lead to home grown industries and power multinational companies within the country. However, since 1964 till now, despite the endowment of the nation with a large population and abundant natural resources, Nigeria is yet to advance economically. Up till now, the nation does not have any globally branded product, multinational company, technical and managerial expertise or worldwide range of Intellectual Property Rights exploited globally that emanated from its indigenous knowledge and industrial efforts (Bindir and Tandama, 2013), While educational and knowledge infrastructure abound in the country with about 125 universities, 125 poly-techniques, 98 colleges of education, over 300 institutions composed of research institutes, innovation agencies

and policy implementation departments, multinational companies, large pool of skilled labour force including a sizeable number of diaspora, the economy is still technologically weak with a very high national poverty incidence that implies that over 100 million Nigerians are living below the poverty line. As the innovation performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation, the disparity in Nigeria leads to low level of economic and technological development. The major actors which involves private enterprises, universities and public research institutes have little or no linkage among them inform of joint research, personnel exchanges, cross carpeting, purchase of equipment, etc. Consequently, technological development remains at its lowest ebb, despite increasing number of research institutes and public and private universities. Thus, while Nigeria produces close to 20 million barrels of crude oil per day and sells at over 60 USD per barrel, a vast majority of the populace continue to live below poverty line (Siyanbola, 2008). In 2005, GDP per capital was just 594 USD which is very low compared to that of most countries with similar development profiles as shown in Table 2. The table also indicated that 34.1% of the population lives below poverty line and over 70% live below 1USD per day. A total of about 90% of Nigerians live below 2USD per day. In the 2010's, while the economy is experiencing steady growth rate of about 7% per annum, unemployment and poverty continue to increase as a result of dependency on a mono economy powered by the export of fuel, a primary product. Also, the Manufacturers' Value Added remains marginally low at about 25% per annum as a result of low adoption and application of innovation systems.

3.0 Industrial Development Patterns in Nigeria

The development of industrial activities in Nigeria has passed through three phases which comprised of the pre-colonial era, the early post colonial era and events since the mid 1980's (Ajayi, 2007). Craft industries were predominant among those that featured in local and inter-regional trade in the pre-colonial era. These include artifacts of wood, brass, bronze, leather, hand woven textiles, bags, iron workings and fire burnt pottery from local clay (Ajayi, 2007). These craft industries featured in different locations in a close contact with available raw materials. The advent of Europeans brought about the first widely recognized forms of modern industrialization in Nigeria. Nigeria thus embraced this type of industrialization as the main panacea to her underdevelopment (Onyemelukwe, 1983). As part of the reconstruction efforts after the political crises which culminated in civil war between 1960 to 1970, the Second Development Plan, 1970-74 had as its primary objectives the rapid expansion and diversification of the industrial sector of the economy and promotion of the establishment of industries which catered for overseas markets in order to earn foreign exchange among others (Ajayi, 2007).

Over the years Nigeria has instituted various other industrialization strategies. These include import substitution, export promotion, balanced development and local resource based industrialization strategies. Anyanwu *et.al* (1997) observed that Nigeria adopted import substitution strategy after independence to lessen over-dependence on foreign goods and to save foreign exchange. However, the result of this strategy turned out to be a mere assemblage of manufacturing items rather than domestic production of them. This pitfall led to the replacement of import substitution strategy with export promotion strategy which embraced the production and exportation of products originally imported. However, inadequate incentives and problems of raw materials led to the failure of the export promotion strategy (Anyanwu *et al*, 1997). Balanced development strategy was introduced due to the lopsided development of the industrial sector.

The main objective of balanced development strategy was to encourage greater linkages within the industrial sector. This is to create intra-industry and inter-sectional linkages and transactions. Local resource-based industrialization strategy was introduced due to the dwindling oil revenues and to stem expenditure of foreign exchange on the importation of raw materials and spare parts for industries by encouraging optimal development and utilisation of local raw materials for industrial production activities

One way of accessing the performance of the industrial sector of the economy is to assess its contribution to the total output produced in the economy. Table 3 shows the contribution of Nigeria's industrial sector to the real Gross Domestic Product from 1960 to 2008. The Table shows that the industrial sector's contribution to the real GDP recorded an upward trend from 1960 to 1966. Its contribution rose from 5.9% in 1960 to 14.2% in 1966. It fell to 14.0% in 1967 and 11.2% in 1968. The table further showed that the contribution of the manufacturing sub-sector ranged from 3.6% to 11.1% from 1960 to 2008 while that of crude petroleum sub-sector increased from 0.4% to 40.5% respectively within the same period. Also solid minerals contribution ranged from 0.2% to 2.6%. However, the contribution of the

manufacturing sector to GDP was highiest from 1960 to 1969 before crude petroleum export took the lead in 1970 with 11.0% and maintained the lead throughout the period. In the mid-eighties the total industrial output ranged from 34.6% in 1981 to 46.2% in 1990. This is the period in which the industrial sector contributed mostly to the real GDP in Nigeria (Olayiwola et al, 2013). As a result of the economic down turn of the 1990's which led to the introduction of the Structural Adjustment Programme and devaluation of naira, the contribution of the total industrial output to GDP decreased steadily from 44.1% in 1991 to 22.0% in 2008. As earlier stated the contribution of local R&D to products development remains very low.

4.0 Problems militating against contribution of innovation to industrial development in Nigeria

The Nigerian STI system overtly depends on government for nearly all its requirements. As a result, a number of implicit and explicit factors influence the performance of Science and Technology Innovation system in Nigeria. Implicit factors such as state of art infrastructure to carry out meaningful research work on competitive basis is absent in most of the organisations as most of the universities and research institutes are not adequately equipped with modern facilities (Bindir and Tandama, 2013). This problem is compounded by lack of steady power and water supply. The need for adequate information on global best practices, sources of grants and the information on current status of development in several disciplines are not available in most of the research scientists. In most universities and research institutes, latest relevant journals are scarce and most researchers are left with the information obtainable on the internet. Other important implicit factors such as training of personnel and funding are absymally inadequate. In addition, the existing R&D reward systems are also clearly inadequate. The explicit factors germane to the successful performance of STI system which include commercialization of R&D results, linkages, quality assurance, Intellectual Property Rights (IPRs) system, entrepreneurship, investment, investors' confidence and marketing strategy are in most cases unorganized and inadequate in public R&D organisations and the universities.

The most important implicit factors limiting the development of a virile Science, Technology and Innovation and consequently, technology development and transfer in Nigeria is funding of research and development activities. Technology transfer typically include a set of activities starting with investment in R&D, the actual R&D performance, decision on how to handle the intellectual property to demonstrate technology and commercialization which brings the products to the market. In this new economic order, developing nations can no longer compete based on their natural resource endowments and locational advantages. For a nation to withstand competition in this era of globalization, there is need for such to identify its niche areas and build it by scientific methods (, 2008). The experiences of Brazil with sugarcane (Goldenberge, 1998) and Malaysia with oil palm (Abiola, 2007), have shown that building scientific capacity and competence in the fields of natural science endowment and locational advantages is a surer way to development. In consciousness of this, most countries now devote an increasing proportion of their resources to science and technology innovation and to the associated Research and Development (R&D) in an attempt to build competitive advantages or to catch up with those who have done so (Siyanbola, 2008).

Another significant problem militating against successful technology transfer from laboratory to the market is the little or no linkage that exists between research institutes, universities and the industry. The opportunity for a country to initiate, maintain and sustain competitive advantage through innovation rests on its ability to create and advance synergy. Though, the number of universities and research institutes in Nigeria is high, the anticipated commercialization has failed mainly due to the lack of connectivity between industry and the academia. This is mainly due to the fact that commercialization of R&D results has not been traditionally, a high priority of universities. The public universities in Nigeria are funded directly from the national budget. Private sector funding of R&D in Nigeria is lagging. In South Korea for instance, the business sector now provides over three quarters of R&D funds (KISTEP, 2007). In the more advanced countries, such as Canada, Germany, UK, and USA, industry
funding of R&D in the academia are 11.8%, 7.5%, 6.2% and 5.5% respectively (Mokhtar, 2005). In these countries, there is strong university-industry linkage. For instance, in 2002, the United States invested an estimated 292 billion dollars on R&D which represented 2.8% of its Gross Domestic Product (Karlsson, 2004). The largest share of the money came from industrial firms (66%), while the federal government invested about 81 billion dollars (Karlsson, 2004). Also, when it comes to performing R&D, industry also account for the largest share (72%) while the remaining portion is performed by the federal government (7%), universities and colleges (13%), Federally Funded Research and Development Centres (FFRDCs) (4%) and nonprofit organizations (4%). In absolute figures, industry

invested 193 billion dollars and performed R&D for 211 billion dollars in 2002 (NSF, 2003a) While it is widely recognized that the federal government support in the United States was a key factor in the creation of the bio technology sector as evidenced by more than 1,200 biotech companies with a combined market capitalization of over 90 billion dollars (Karlsson, 2004), in Nigeria, research programmes are rarely directed in a proactive manner at providing implementable solutions to practical and enterprise problems (Bindir and Tandama, 2013). Very often, research products and innovations are not scrutinized for prospects of commercialization and wider adoptability. According to Bindir and Tandama (2013), a major factor leading to this situation is the absence of institutional arrangement to midwife and nurture linkages between university and industry. There is currently inadequate and in some cases non-existing operational framework for multilateral partnering and innovation networking of the universities, business community and the government. Essentially, there is poor correspondence between expectations/needs of the private sector and the research priorities in the universities. This is a clear departure from the American experience where university research results are believed to lie behind the creation of several competitive firms and block buster products ranging from pharmaceuticals to computer hardware and software (Arundel and Bordoy, 2013). Another reason for the American success in commercialising public science is the substantial licencing income that universities such as Stamford, Colombia, MIT and the University of Florida have earned from patenting their inventions. The causes of failure by Nigerian scientists could be attributed to a wide range of factors including a lack of entrepreneural spirit among scientists, barrier to the ability of public sector scientists to move to the private sector on a temporal basis to develop their discoveris and to poor Intellectual Property Right of university inventions. Currently in Nigeria, existing approaches for linking research with private enterprise take the form of research products fairs, experimental incubator models and incoherent outreach approaches (Binder and Tandama, 2013). On the other hand, the organized private sector, including industrialists, business people and agriculturists, hardly shows confidence or stake in the existing linkage systems. Hence, the solutions to local industry problems are often sought without recourse to the skills, capabilities and opportunities within the university system (Bindir and Tandama, 2013). In Organization for Economic Cooperation and Development (OECD) countries, knowledge and research generated by public research system is diffused through a variety of channels. These include mobility of academic staff, scientific publications, conferences, contract research with industry and licensing of university inventions. Much of the policy forms in OECD countries have centred on promoting knowledge transfer via a dual, but rather linear model of commercialization. This model is characterized by several push forces whereby universities and public research institutes transfer academic inventions via the sale, transfer or licensing of intellectual property, often on an exclusive basis to existing firms or new ventures. The converse of the model is a demand-pull model based on contract research or collaborative research and development whereby universities and public research institutes are solicited by industrial actors to find solution to production and innovation problems (OECD, 2012). Neither of these forms are entrenched locally.

5.0 Funding of Research and Development in Nigeria

The major sponsorship for R&D in Nigeria comes from is the government. Government spending on R and D is of the order of about 90% for most of the developing countries. In comparism, the same is about 40% for many developed countries. Despite this however, R&D institutes in Nigeria has not been able to meet the expectations of either the industry or policy planners. In Nigeria, there is an emergent awareness of the contribution of science and technology to national development. According to (Siyanbola, 2008), this is evidenced by consistent increase in budgetary allocations to S&T in recent times. From N1.5 billion in 1998, the Federal Government increased S&T allocation to N5 billion in 2004. This 233% increase averaged about 33% each year over the 7 year period. By 2007, federal allocation to S&T had increased to N16.0 billion representing 220% increase from 2004 and a 730% rise from 1998 (Siyanbola, 2008). While the amount increased in quantum, these amounts represent a meagre percentage of national GDP. For instance, the federal allocation to S&T in 2006 estimated at US116 billion or N14,900 billion amounted to only 0.11% of the GDP a far cry from UNESCO's recommended 1%. In the absence of any serious local funding for R&D, most researchers turn to foreign donor agencies and institutions that set the research agenda that may not necessarily address local problems (Siyanbola, 2008). In addition, if research must be carried out as dictated by the need for paper publication and promotion purposes, most times, basic research identified by Frascat-Manual (2002) and Yusuf (2012) as experimental or theoretic work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts without any particular application in use are embarked on. The main aim of this research is to gain deeper knowledge or understanding of the subject without specific application in mind. Basic research does not have specific immediate commercial objectives, although it may be performed in fields of present or potential commercial interest. The outcomes/ results are not generally sold but are usually published in scientific journals or circulated to interested groups. Applied research on the other hand are undertaken as original investigation to acquire new knowledge. According to Frascati-Manual (Siyanbola, 2002), it is primarily directed

towards a specific practical aim or objective to gain knowledge in meeting a specific and recognised need. In industry, applied research are undertaken to discover new scientific knowledge that has commercial objectives with respect to products, processes or services. This type of research gives operational forms to ideas and the knowledge or information obtained from it is often patented but may also be kept from the public. The third type of research, the development research is the systematic use of the knowledge derived from research directed towards production of useful materials, devices, systems or methods including the design and development of prototypes and processes. This type of research is systematic in nature, inferring from knowledge gained through research and practical experience which is directed to producing new products, devices as well as installing new ones and improving the existing ones. The outcomes are intended primarily to produce particular products that will be able to meet customers expectations in the market or a product that will enhance productivity. In the US, the universities and colleges performed approximately 53.8% basic research and the federal government estimated to have provided 58.90% basic research funding in 2002. During the same period, industry accounted for 65.7% of all applied research while federal laboratories and universities accounted for the rest. Larger percentage of the funding for applied research emanated from private firms and the federal funding for applied research was 70% that of basic research. Expenditures on development research totalled 161.8 billion USD in 2002, representing majority of U.S. R&D expenditures. The development of new and improved goods, services, processes is dominated by industry which performed 89% of all U.S development research. Industry also provide 81.4% of the fund while the federal government provided 17.6% of the entire fund.

6.0 Commercialization of the Research Results

Commercialization of research results has become the new catch-cry in most advanced economies as they embrace innovation as a key driver of economic policy. The transfer, exploitation and commercialization of public research results has become a critical area of science, technology and innovation. The knowledge and research generated by public research system is diffused through a variety of channels among which are the mobility of academic staff, scientific publications, conferences, contract research with industry and the licencing of university inventions. Effective commercialization of research results in any nation will depend on rapid technological innovation, effective strategic management of knowledge and a clear focus in value added goods, services and industries. According to Bently (2013), the world faces major issues such as climate change, limited natural resources and changing age demographics. Thus the need for transition to a more sustainable economy is creating global market oppurtunities for entirely new solutions. Advancement in technology development has radically altered the economic system in the world. Nation and businesses that can achieve higher levels of performance in innovation will be well placed to be leaders of tommorrow. Thus, wealth is no longer being measured in terms of physical winch alone. It must be measured by the degree of access to, and timely use of knowledge and technology that leads to intensive value added capabilities. Thus, commercialization of research findings is becoming an important aspect of economic development. However, while commercialization has led to substantial investments in public research in America, the perception in Europe is that the continent has failed to benefit from its substantial invesments in public research. European governments have responded by introducing policies to promote commercialization such as introduction of university courses on entrepreneurship for future academics and a range of other programmes to encourage technology transfer by promoting formal contractual relationships between the business sector and public science (Appiah *et al,* 2012). In India, the development and commercialization of new technologies have become very important in the research agenda. Even though India started development of its scientific infrastructure in a planned way immediately after independence, commercialization of technology attracted the attention of policy makers only in 1980's. According to Kumar and Jain (2003), venture capital funds was established in the 1980's and a technology policy statement was also introduced in 1983 to provide risk-sharing funds as well as managerial expertise for technology development and commercialization.

In 1996, the Ghana government restructured the Council for Scientific and Industrial Research (CSIR) to make it more responsive to private sector needs and to promote demand driven research (Appiah *et al*, 2012). To ensure that research institutions are partly self financing, a commercialization policy was incorporated into the activities of CSIR by an act of Parliament (Act 521 of 1996). According to Appiah *et al* (2012), although, the implementation started in 2003, all CSIR institutes were tasked to

- Cover at least 30% of their operational costs from internally generated funds (Sources of Income), and
- Offer improved value for money by providing quality products and services to justify expenditure.

Since the introduction of the policy, commercialization pace has been quite slow for all CSIR institutions (Appiah *et al,* 2012). The average performance of most of the institutes has been under 5.0% (CSIR-CCID Task Team, 2002). While implementation of the commercialization policy by relevant institutions under the CSIR will

be of significant value, various challenges hinder the efforts of the relevant institutions from achieving the perceived benefits. Among this is the need to reinforce managerial initiatives that will enhance successful implementation of the drive at CSIR and enable all research institutes perform accordingly (Yawson, 2012). In a study reported by the Appiah *et al,* (2012) on the effect of the commercialization policy on the performance of the CSIR- Forestry Research Institute of Ghana, it was observed that majority of the respondents were aware of the policy. Commercial products and services at the institute increased significantly from seven prior to implementation of the policy to about twenty after the policy. It was also reported that the financial performance of the institute over a twelve year period (1996-2008) and after the introduction of the commercialization policy in 1996 recorded significant increase of over 1000%. However, various set-backs such as weak marketing strategy and obsolete equipment accounted for slow implementation of the policy (Appiah *et al* 2012). Based on the outcome of the study, Appiah *et al* (2012) recommended the need for vigorous education and sensitization of staff to embrace the policy as well as the improvment of the institute's current marketing strategies.

In Nigeria, the Intellectual Property Right (IPRs) of innovators and industrialists are governed by Patent and Design Act cap 344 of 1990, Trademarks Act Cap 436 of 1990 and Copyright Act of 1998 (Ukpabi, 2009). Managing Intellectual Property Rights and Technology transfer issues in Nigeria has been part of the core mandates of the National Office for Technology Aquisition and Promotion (NOTAP). To ensure a link between R&D activities carried out in the country and the market, and facilitate process of commercialization, NOTAP has established over 23 Intellectual Property and Technology Transfer Offices (IPTTO's) in tertiary institutions across Nigeria and assist innovators to prepare and file applications for property rights. Nevertheless the number of applications for rights protection filed by public RI's between 1999 and May 2012 was lower than those filled by private innovators, indicating that the public RI's are less interested in rights protection and consequently commercial exploitation of their results (*et al,*2012).

Presently, over 100 commercializable R&D outcomes in the areas of agriculture , Industry, Engineering, and Health have been successfully produced by agencies under the |Federal Ministry of Science and Technology in Nigeria (*et al*, 2012). Less than 2% of R&D in Nigeria have been commercialised In view of this, Siyanbola *et al* (2012) recommended a change in commercialization strategy in Nigeria through adoption of new strategic approach. The model advocated by Siyanbola *et al* (2012) acknowledges the role of networking and collaboration among key stakeholders in the commercialization process. Essentially the model involves storing all R&D outputs in a database that will be connected by commercialization agents to the market. The agents who are experts should be made of economists, policy makers in S&T and finance experts draw from Commercial Banks, Bank of Industry, Central bank of Nigeria, the Manufacturers Association of Nigeria, as well as representatives of cognate ministries such as the Federal Ministry of Trade and Investment. With the attachment of two sets of Strategic Actors I & II to the commercialization agents, Siyanbola *et al* (2012) observed that this will facilitate the privatization process. According to the model, Strategic Actor 1 will comprise of actors that will make use of R&D outputs and process them into finished products. These actors include National Directorate of Employment (NDE), the National Youth Service Corps (NYSC) and Small and Medium Enterprises Development Agency (SMEDAN) as well as agencies of government for employment promotion. The Strategic Actors II, according to Siyanbola *et al* (2012), will be responsible for sensitisation and advocacy in patronising goods produced in Nigeria. These would include National Orientation Agency (NOA) and the National Institute for Cultural Orientation (NICO). While this approach may facilitate post mortem interactions between public research centres and the private sector after the R&D results are out, it does not recognise the need for initial interaction between the public RI's and the private sector.This initial interaction is often necessary as it may lead to assessment and determination of industrial needs and requirements. Consequently, the approach may not yield desired results if not modified to take cognisanse of needs of the private sector in order to tailor R&D towards them.

7.0 Strategies for Optimising Commercialisation of Innovations from Public Research Institutes and Universities.

The facilities in the public RI's and Universities in Nigeria have degenerated so much that most are operating at the lowest ebb of infrastructural availability. In the 70's most public research Institutes and Universities were at par with those in the United Kingdom and the United States of America vis a vis quality and quantity of state of art equipment and facilities. As from the mid part of 1990's to the present, the Nigeria economy had been bastardised and development nosed dived as a result of policies that encouraged the devaluation of the naira and acute corruption in the polity. Today, most public RI's and universities in Nigeria are parading obsolete equipment where available. This is retrogressive and negates the principles of sustainable development. It also led to questioning the quality of innovations obtainable at such institutes. This perhaps may have been part of the

issues the public university lecturers in Nigeria are agitating for improvement of facilities and conditions of service which has led to five months industrial action by the lecturers in Nigeria. According to Okebukola (2002), by 1996, the quantity and quality of research in public universities had declined to an all time low. This has led to low level of local patents in the Country. For instance, only 74 local patents (as against 122 foreign patents) were registered in Nigeria betwen 2000 and 2006 while the figures are in range of tens of thousands for China and India (Siyanbola, 2008). According to Akinsola (2007), the Obafemi Awolowo University obtained 47 grants for projects between 1998 and 2002, and 87 between 2003 and 2007, most of the projects were either surveys, impact analysis, appraisals, evaluation and analytical studies that may not impact directly on industrial development. Thus, as a matter of urgency, there is need for upgrading facilities in public RI's and Universities in the Country.

As has been reported by various authorities, Nigeria is blessed with multivarious raw materials. These include agricultural and mineral raw materials. Presently in Nigeria, efforts are being made by different public RI's and tertiary institutions to develop these raw materials simultaneously. This has led to duplications, waste of scarce resources and manpower. Fortunately the Nigerian manufacturing industry is made up of ten sectors, each with easily identifiable raw material problems. In the wood and wood products and the pulp and paper sectors of the economy, the major problems are dwindling availability of economic wood resources and absense of local source of long fibre raw materials respectively. These have led to closure of industries and disengagement of the workforce in a number of industries. These calls for a strategic plan that will delibrately outline and analyse the raw material problems within the sectors and build scientific capacity and competences in the areas identified for sustainable development and production of raw materials for such industries locally. Building competitive advantages in these fields will reduce foreign exchange expenditure and enable the country to supply the vast market available in West Africa or to catch up with countries with such advantages. Also this will asssit in the identification of raw materials on which exhaustive national R&D will be concentrated in order to identify all useful products and components of industrial relevance as was done for sugar in Brazil and Oilpalm in Malaysia.

Today, the public RI's and universities depend solely on government funding of research and development activities. As government resources are dwindling due to absolute dependence on oil export, the amount of money available for funding public R&D also have to reduce. This is a major bane of industrialization in Nigeria. Thus it has become imperative for both the public research institutes and universities to restrategize and embark research and development prospects that have commercial interest. This strategy is behind the success and wealth of a number of American Universities such as the Massachussets Institute of Technology (MIT), Stamford, Colombia and a host of others that have earned substantial licencing income from patenting their inventions. While this may not be as easy as it appears, the government can respond to this problem as the European paradox by introducing policies to promote commercialization, such as university courses on entrepreneurship for future academics and a range of other programmes to encourage technology transfer by promoting formal contractual relationships between business sector and public science. These include subsidies for the establishment of technology transfer offices (TTO's) at universities, change in IPR regulation for universities to obtain higher share of their research funding from the private sector (Callen and Corvants, 2006).

Closely allied with the above is the need to make commercialisation a major mandate of the public RIs and universities. This could be achieved by the approach adopted by Ghana where 30% of running costs of public RIs must be internally generated. This approach will achieve Four major objectives. First it will encourage linkage between public RIs and the private sector. Second, it will enable that focused research with industrial potentials are carried out and third, it may inculcate entrepreneurship idea into the scientists and four, it will ensure that only profit and commercial oriented public research organisations as well as departments that can function by ensuring that commercilizable R&D to attract patents or copyrights are established in the future in the universities.

There is also the need for government to emphasize that small and medium enterprises in Nigeria should solve technical barriers on site by the utilisation of local university technology development support and creation of joint industry- university technology development systems (Kim, 2012). A major aspect of the technology transfer commercialization programme in Korea is the technology transfer subsidy initiative. The programme subsidizes part of the technology implementation cost when when the transferred technology obtained through designated technology transfer organisations is to be commercialised. It subsidizes up to 70% of the technology provider costs when the technology is transferred from research centres, universities, corporations, etc. In addition, in Korea, the small and medium business transfer promotion programme is a system where a part of additional technology funds required for the commercialisation of technology transferred from domestic and overseas universities, research organisations, corporations are subsidized. The programme provides up to 75% of

the total development cost for technologies that can be merchandized within a year. In addition the patented technology promotion programme is initiated to promote superior patented technology transfer and patented technology commercialisation by providing loans for funding the commercialization process and supports patented technology that can be merchandized within 3 years (Kim, 2012). Apart from the above, the government also established a Korea Technology Credit Guarantee Fund which guarantees the technologyadopted t by firms based on a technology evaluation enabling loans that are obtainable from banks without collateral.

8.0 Conclusion

The national industrialisation strategy based on local raw materials development and utilisation in the industry cannot succeed with adequate innovation. Primary raw materials are complex compounds that require adequate processing and beneficiation before it can be used as an industrial raw material. This process require adequate research and development in laboratories with state of art equipment. Thus, for this strategy to succeed locally, and to promote Nigerian brands and services of global standard, Nigerian government must upgrade facilities in the public RIs and Universities. Coupled with this, research scientists should be should be adequately motivated and fluidity of ideas, training, etc., be encouraged between public RIs, Universities and the industry. Closely allied with this, government R&D funding should be increased to at least 1% of GDP as stipulated by UNESCO. The commercialisation process as it is presently practised is not very proactive. It is important the government take more interest in this process by earmaking subsidies and loans to facilitate the process in line with the Korean example. Duplication of R&D is very rife in public RIs and Universities. To curtail this, it is imperative that a central coordinating body should be established to coordinate activities while inter and intra RIs with similar mandates be encouraged.

References

Abiola, B. (2007). Divergent Paths of Development: Innovation Systems of Nigeria and Malaysia. Geust Seminar at the National Centre for Technology Management , Obafemi Awolowo University, Ile Ife.

Ajayi, D.D. (2007). Recent Trends and Patterns in Nigeria's Industrial Development. Africa Development. Vol. XXXII, No 2. pp 139-155

Akinsola, A. (2007). Analysis of projects funded by the University Research Committee from 1997 to 2002according to Departmrnt and Faculty. Obafemi Awolowo University, Ile Ife.

Anyawu, J.C., A. Oyefusi, H. Oiakhenam, F.A. Dimowo (1997). Structure of Nigerian Economy. Onitsha; Joanee Educational Publishers.

Appiah, N., Agyapong, A. and A. Asamoah (2012). Effects of commercialisation policy on the performance of CSIR-Forestry Reserach Institute of Ghana. Ghana J. Forestry 28(1): 51-63

Bently, N. (2013). Executive Summary. Innovation- the successful exploitation of ideas- is a key driver of economic growth for developed countries. Concept to Commercialization. 2011-2015. Technology Strategy Board.

Bindir, E.U and Tandama, A.A. (2013). Commercialization of Research and Development Outputs. In A.P. Onwualu, A.A. Ogunwusi, E.A. Inyang and I Olife (eds) Raw Materials for the Transformation of the Industrial Sector in Nigeria. pp377-402.

Callan, B. and Cervantes, M.(2006). Managing intellectual property rights from public research. In Putnam J.D (ed) Interllectual Property and and Innovation in Knowledge Based Economy. Pp 14-1 to 14-33.

Central Bank of Nigeria (2008). The changing structure of Nigerian economy and implications for development. Lagos Realm Communication Ltd.

CSIR-CCID Task Team(2002). Report on the In House Reviewof CSIR Commercialization Plans Accra pp 2-5.

Federal Ministry of Science and Technology (FMST) (2010). The national policy for innovation in Nigeria. A paper presented at the National Workshop on Strenghtening Innovation and Capacity Building in the Nigerian Manufacturing Sector, July 20-21, 2010.

Frascati-Manual (2002). Proposed Standard Practice for Surveys for Surveys and Experimental Development. 6th Edition OECD. 30pp.

Goldemberge, J. (1998). A guest essay: What is the role of science in develoing countries?. Chemistry International, 20(6) pp. 168-170.

Karlsson, M. (2004). Commercialization of Reserach Results in the United States. An Overview of Federala dnAcademic Technology Transfer. A2004:007. Swedish Institute for Growth Polocy Studies.

Kim, Y. R. (2012). Technology Commercialization in Republic of Korea. Korea Technology Transfer Centre. 18 pp.

Korean Institute for Science and Technology Poilicy (KISTEP) Database (2007).

Kumar, V. And Jain, P.K. (2003). Commercialization of new technologies in India: An Empirical study of perceptions of technology Institutions, India Institute of Technology, India pp113-120

Mokhtar, N. (2005). The Economics of Innovation . Paper Presented during the Malaysian Economic Outlook Conference Organised by ASLI. 3rd February, 2005.

OECD (2005). Oslo Mannual (Paris). p 30.

OECD (2012). OECD Science, Technology and Industry Outlook (Paris) 2012.

OECD(1997). National Innovation Systems. OECD Technical Publication. 48pp

Okebukola, P. (2002). The state of university education in Nigeria. National Universities Commission, Abuja.

Olayiwola, S.O., Oluseyi Awe, T.A. and Ajagbe, T.F (2013). Higher education expansion and industrial growth in Nigeria. Central Education Service, Lagos 23pp

Onyemelukwe, J.O.C. (1983). Stuctural and locational characteristics of manufacturing . In J.S Oguntoyinbo, , O.O Areola, M. Filani (eds.) A Geography of Nigerian Development, 2nd Edition, Ibadan: Heinemann Educational Books Ltd, pp 296-310.

Oyelaran-Oyeyinka, B. (2008). SME: Issues, Challenges and Prospects.Invited presentation at CBN Financial Sector Strategies (FSS). International Conference, Abuja.

Siyanbola, W. O. (2008). Isnt there a better way?. The case for a paradigm shift in R&D in Nigeria. Proceedings of the third Conference on Science and National Development, 2008. 17pp

Siyanbola, W.O., Owolabi, O.O., Adeleke, Y.S. and Abdullahi, K. (2012). Strategic Approach to R&D Commercialization in Nigeria. International Journal of Innovation, Management and Technology 3(4):382-386.

Teece, D. (2007). Explicating dynamic capabilities: the nature and microfoundations of sustainable enterprise performance. Stategic Mangement Journal. 28(7): 501-528.

Ukpabi, U.J. Potential of protected local innovations in catalyzing Nigerian agro industrial development. Journal of Agricultural Biotechnology and Sustainable Development. Vol. 13 pp 62-68. December, 2009.

UN(United Nations) (2012). Fostering Innovative Enterprenureship. Challenges and Options. United Nations Commission for Europe. New York and Geneva. ISBN: 978-92-1-117056-6. 68pp

Yawson, R.M. (2002). Technology commercialization and intellectual property rights in Ghana. The Conference on TRIPS- Next Agenda for Developing Countries. Hyderabad, India. 13pp.

Yusuf, A.K. (2012). The Research Scene in Nigeria's Non University Higher Institutions JORIND 10 (2):1-8.

Table 1: Ranking of Countries according to Innovation Capacity

Group I **Frontier Countries**	*Group II* **Fast Followers**	*Group III* **Fast Followers**	*Group IV* **Lagging Followers**
.United States	21.India	36.Ukraine	61.Kazakhstan
2.Japan	22.Portugal	37.Croatia	62.Moldova
3.Sweden	23.Ireland	38.Pakistan	63.Kyrgyz Republic
4.Germany	24.Poland	39.Malaysia	64.Guatemala
5.Switzerland	25.Hungary	40.South Africa	65.Peru
6.France	26.Slovenia	41.Bangladesh	66.**NIGERIA**
7.United Kingdom	27.Turkey	42.New Zealand	67.Panama
8.Canada	28.Australia	43.Belarus	68.Azerbaijan
9.Italy	29.Czech Republic	44.Thailand	69.Syrian Arab Republic
10.Finland	30.Mexico	45.Estonia	70.Ecuador
11.Isreal	31.Slovak Republic	46.Tunisia	71.Gabon
12.Republic of Korea	32.Greece	47.Phillipines	72.Benin
13.Australia	33.Romania	48.Russia	73.Congo Republic
14.Hong Kong, China	34.Brazil	49.Lithuania	
15.Belgium	35.Bulgaria	50.Latvia	
16.Spain		51.Jamaica	
17.Netherlands		52.Jordan	
18.China		53.Argentina	
19.Norway		54.Egypt, Arab Rep.	
20.Denmark		55.Indonesia	
		56.Costa Rica	
		57.Vietnam	
		58.Colombia	
		59.Chile	
		60.Venezuela, RB	

Source:Oyelaran-Oyeyinka, 2008

Table 2: Selected Development Indicators for Selected Economies

Country*	Per Capital GDP	% population below poverty line	% population below $1/day	% population below $2/day
Japan	36501	-	-	-
South Korea	14265	..	<2	<2
Chile	5838	17.0	<2	9.6
Malaysia	4731	15.5	<2	9.3
South Africa	3489	..	10.7	34.1
China	1283	4.6	16.6	46.7
Nigeria	594	34.1	70.2	90.8

*Data for most recent available year

Source: Human Development Report, 2001; 2005; 2006

Table 3: Nigeria's Industrial Sector Contribution to Real Gross Domestic Product (NMillion)

Year	Total GDP	Crude Petroleum &Natural Gas	% of GDP	Solid Minerals			% of GDP	Manufacturing			% of GDP	Total Industrial Output	% of GDP
				Coal Mining	Metal Ores	Quarrying & other Mining		Oil Refining	Cement	Other Man.			
1960	2,489.0	11.0	0.4	1.8	9.0	9.8	0.8	-	-	114.0	4.6	145.6	5.9
1961	2,501.2	23.2	0.9	2.0	9.4	10.2	0.9	-	-	127.6	5.1	172.4	6.9
1962	2,597.6	29.0	1.1	2.0	9.6	13.4	1.0	-	-	146.4	5.6	200.4	7.7
1963	2,825.6	32.8	1.2	1.8	10.0	14.2	0.9	-	-	170.7	6.0	229.5	8.1
1964	2,947.6	61.8	2.1	2.4	10.4	15.0	0.9	-	-	181.0	6.1	270.6	9.2
1965	3,146.8	116.8	3.7	2.8	10.8	19.4	1.0	-	-	221.0	7.0	370.8	11.8
1966	3,044.8	179.2	5.9	1.6	10.6	19.0	1.0	-	-	221.6	7.3	432	14.2
1967	2,527.3	137.0	5.4	0.2	10.4	16.2	1.1	-	-	190.0	7.5	353.8	14.0
1968	2,543.8	61.0	2.4	0.0	10.4	13.5	0.9	-	-	200.4	7.9	285.3	11.2
1969	3,225.5	232.0	7.2	0.0	9.6	19.7	0.9	-	-	263.4	8.2	524.7	16.3
1970	4,219.0	465.6	11.0	0.2	8.6	27.1	0.9	-	-	317.6	7.5	819.1	19.4
1971	4,715.5	657.2	13.9	0.7	7.9	38.5	1.0	-	-	307.7	6.5	1012	21.5
1972	4,892.8	777.0	15.9	1.0	7.3	48.3	1.2	-	-	381.1	7.8	1214.7	24.8
1973	5,310.0	882.8	16.6	0.9	9.4	50.7	1.1	-	-	472.7	8.9	1416.5	26.7
1974	15,919.7	3,392.7	21.3	-	-	352.7	2.2	-	-	1,182.0	7.4	4927.4	31.0
1975	27,172.0	5,770.6	21.2	-	-	505.9	1.9	-	-	1,186.5	4.4	7463	27.5
1976	29,146.5	6,979.0	23.9	-	-	717.3	2.5	-	-	1,463.6	5.0	9159.9	31.4
1977	31,520.3	7,071.6	22.4	-	-	833.4	2.6	-	-	1,695.6	5.4	9600.6	30.5
1978	29,212.4	6,225.6	21.3	-	-	647.2	2.2	-	-	2,169.0	7.4	9041.8	31.0
1979	29,948.0	7,637.6	25.5	-	-	627.0	2.1	-	-	2,599.2	8.7	10863.8	36.3
1980	31,546.8	6,754.3	21.4	-	-	682.7	2.2	-	-	3,489.9	11.1	10926.9	34.6
1981	205,222.1	73,019.7	35.6	1.3	44.2	2,169.7	1.1	150.5	587.2	13,100.3	6.7	89072.9	43.4
1982	199,685.3	65,227.8	32.7	0.6	33.0	2,211.6	1.1	156.4	688.4	14,786.8	7.8	83104.6	41.6
1983	185,598.1	59,458.0	32.0	0.6	27.1	1,684.7	0.9	114.6	243.8	10,439.0	5.8	71967.8	38.8
1984	183,563.0	66,884.3	36.4	0.8	20.7	1,450.2	0.8	112.9	153.3	9,266.6	5.2	77888.8	42.4
1985	201,036.3	72,152.0	35.9	1.5	15.0	896.5	0.5	160.8	766.6	11,105.1	6.0	85097.5	42.3
1986	205,971.4	70,791.0	34.4	1.5	3.5	482.3	0.2	80.9	828.7	10,673.1	5.6	82861	40.2
1987	204,806.5	69,014.8	33.7	1.3	11.7	527.1	0.3	119.0	705.2	11,217.4	5.9	81596.5	39.8
1988	219,875.6	70,837.0	32.2	0.9	13.3	580.8	0.3	136.0	919.1	12,658.8	6.2	85145.9	38.7
1989	236,729.6	79,321.9	33.5	0.9	13.6	623.8	0.3	177.0	967.4	12,887.1	5.9	93991.7	39.7
1990	267,550.0	108,233.4	40.5	0.9	12.1	652.6	0.2	174.9	680.0	13,847.5	5.5	123601.4	46.2
1991	265,379.1	91,313.9	34.4	1.6	8.3	678.7	0.3	186.5	756.6	16,135.4	6.4	109081	41.1
1992	271,365.5	93,614.3	34.5	1.0	4.9	705.2	0.3	182.8	770.4	14,404.0	5.7	109682.6	40.4
1993	274,833.3	93,810.1	34.1	0.4	5.1	740.5	0.3	181.0	799.0	13,809.1	5.4	109345.2	39.8
1994	275,450.6	91,387.4	33.2	0.2	6.0	762.7	0.3	178.3	728.2	13,684.8	5.3	106747.6	38.8
1995	281,407.4	93,536.7	33.2	0.1	6.4	783.3	0.3	189.6	714.4	12,932.2	4.9	108162.7	38.4
1996	293,745.4	100,239.0	34.1	0.1	7.0	792.7	0.3	211.3	680.7	13,061.5	4.8	114992.3	39.1
1997	302,022.5	101,317.0	33.5	0.2	6.4	843.4	0.3	207.9	701.4	13,100.7	4.6	116177	38.5
1998	310,890.1	103,923.5	33.4	0.2	6.4	894.0	0.3	186.6	270.0	12,589.7	4.2	117870.4	37.9
1999	312,183.5	96,129.2	30.8	0.2	6.6	928.0	0.3	195.2	269.1	13,030.4	4.3	110558.7	35.4
2000	329,178.7	106,827.5	32.5	0.2	6.8	963.2	0.3	193.3	267.9	13,497.6	4.2	121756.5	37.0
2001	356,994.3	112,417.4	31.5	0.2	6.4	1,059.6	0.3	562.7	309.8	14,062.6	4.2	128418.7	36.0
2002	433,203.5	106,002.1	24.5	0.1	6.4	1,105.6	0.3	518.4	313.2	15,607.8	3.8	123553.6	28.5
2003	477,533.0	131,336.6	27.5	0.1	6.2	1,166.2	0.2	567.6	325.6	16,476.4	3.6	149878.7	31.4
2004	527,576.0	135,670.7	25.7	0.1	6.8	1,372.4	0.3	624.3	358.2	18,454.3	3.7	156486.8	29.7
2005	561,931.4	136,345.5	24.3	0.1	7.6	1,503.2	0.3	686.8	397.8	20,220.5	3.8	159161.5	28.3
2006	595,821.6	130,193.6	21.9	0.1	8.5	1,657.5	0.3	755.6	443.7	22,106.6	3.9	155165.6	26.0
2007	634,251.1	124,285.1	19.6	0.2	9.5	1,868.8	0.3	831.8	497.0	24,206.8	4.0	151699.2	23.9
2008	674,889.0	118,367.3	17.5	0.2	10.6	2,107.5	0.3	915.0	555.9	26,434.2	4.1	148390.7	22.0

Source: Central Bank of Nigeria Statistical Bulletin, 2008

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar