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Technology Transfer, A Panacea for National Development: A reflection of the Federal Institute of Industrial Research, Oshodi

Felicia S. Adeyemo[1*] and Rasaq K. Ogundeji[2]
[1]Caleb University, Imota, Lagos Nigeria
[2]Federal Institute of Industrial Research, Oshodi, Nigeria

*Corresponding author
Email: feliciaadeyemo@yahoo.com

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ABSTRACT

There is global awareness of the tremendous impact technology transfer can make on economic development. Successive Nigerian governments being fully aware of this, have made concerted efforts over the years towards transferring foreign and locally developed technologies to user-industries. Unfortunately, these efforts have not yielded the desired results. This study investigates the efforts of the Federal Institute of Industrial Research, Oshodi (FIIRO) in its bid to transfer locally developed technologies to user industries since the 1980s and why those efforts have not been effective. The study reveals that strategies employed by the Institute include training workshops, technical assistance services, licensing and sponsored research. The study also showed that factors impeding Nigeria's efforts in technology transfer include inadequate infrastructural support and funding of government research/allied institutions, stiff competition from foreign goods, lack of adequate political will and support by government, and poor remuneration of R&D and academic personnel among others. The study recommends adequate funding of technology transfer processes from the laboratory to the market and the protection of local industries from foreign competition among others.

Keywords:
Nigeria, Technology transfer, Developed economics, Training workshops

1.0. Background Information

Unlike Nigeria, many developed countries especially in Asia and Latin America have made giant strides in the utilization of technology transfer mechanisms for economic development. This has resulted in their ability to experience technological break-through in the different sectors of their societies coupled with improving the living standards of their citizens. Nigeria on the other hand is finding it hard to provide her people basic amenities such as good road networks, power, water and food (Harry, 2013). One can wonder why this is so or what developed countries are doing differently. Governments of nations are aware of the place of technology transfer in the economic development of any country. In Nigeria, successive governments have taken positive steps in establishing research institutions to explore possible solutions to the crucial developmental challenges of the nation. These problems include dependence on foreign technologies and export of raw materials coupled with uncoordinated research activities. Examples of such research institutes are Cocoa Research Institute of Nigeria (CRIN), Ibadan, and the Federal Institute of Industrial Research, Oshodi (FIIRO), among others. Some of their research mandates include raw materials development and utilization, process formulation, equipment design and fabrication, manpower development, upgrading indigenous technologies and transferring the developed technologies to end users (Koleosho, 1987; Olatunji, 2001; Ilori, 2006). This study focuses on the technology transfer efforts of FIIRO.

1.1 Federal Institute of Industrial Research, Oshodi (FIIRO)

The Federal Institute of Industrial Research, Oshodi, the first industrial research institute in the country was established in 1956. At inception, the mandate of the Institute was to assist in accelerating the industrialization of the Nigerian economy through finding use for the country's raw materials and upgrading indigenous production technologies. According to Adeyemo *et al.* (2004), the Institute's mandate at inception was focused on three areas:

a) characterization of local raw materials for use in industries;
b) identification of appropriate technologies and assisting in the transfer, adaptation and utilization by local industries and;
c) upgrading indigenous processing methods into modern technologies

In pursuance and fulfillment of its mandate, the Institute has over the years conducted research and development in areas such as converting cassava into *fufu*, *gari*, chips, starch and flour; processing instant pounded yam flour, soy *ogi* production, and smoking fish among others. Bio-technology applications used in the production of mushroom, fruit juice, and bottling and preserving drinks such as palm wine, *Zobo* and *Kunu* food drink have also been developed. The institute has also conducted research in laundry and toilet soap production, toilet cleansers, and body and hair pomade production, and producing jute bags from *Kenaf*. Food processing technologies used in soap production, fish smoking, dyeing, and dehulling and roasting groundnuts have also been developed. The ultimate goal of the Institute's mandate is to ensure that these developed technologies are transferred to industries and other end users who have the potential for commercially exploiting these technologies.

The Institute has made efforts to transfer its technologies through various modes which include training workshops, technical assistance services, licensing agreements, contract research and sponsored research. Others efforts were made through collaborations and partnerships with foreign and local bodies, industries, tertiary institutions, partnership on techno-preneurship development and the annual engagement of students from tertiary institutions.

1.2 Main Focus of Study

Technology transfer has yielded fruits in terms of economic development in other countries such as Europe, America, and the Asian tigers, among others. The questions we therefore need to reflect on are:

a) Why has Nigeria not benefitted from technology transfer like other countries despite several interventions?
b) What are the constraints inhibiting technology transfer?

Hence, the objective of this study is to attempt to examine why technology transfer efforts made by FIIRO have not yielded expected results.

2.0. Literature Review

Technology can be defined as the application of specialized knowledge for the achievement of a

practical purpose. It can as well be explained as the application of scientific knowledge in the development of a product or provision of a service for the satisfaction of an existing or new need (Ramanathan, 2014). According to Ake (1984), technology can be depicted in terms of highly skilled manpower in scientific, technical, and engineering fields and the percentage of expenditure on research and development of gross domestic product. In summary, technology is the totality of knowledge, techniques, and procedures used in meeting human needs (Adeyemo, 2008; Ilori, 2010).

2.1.The concept of technology transfer, its role and importance

Technology transfer is the process by which a developer of technology shares skills and knowledge with respect to the technology with a commercial user that has the potential to exploit the technology. Technology transfer can also mean the dissemination of information on methods of manufacturing of products by privately or publicly owned research centres or the process of movement of technology, that is, physical assets, know- how and technical knowledge from the manufacturing centre to the commercial partner to enable the latter put the transferred facilities to commercial use. In some cases, technology transfer may involve the exchange of personnel (Sagar, 2014) and capabilities (Lundquist, 2003). Summarily, technology transfer can be the movement of technology from laboratory to industry or from developed to developing countries. Harry (2013) noted that technology can be invented in one part of the world and utilized in another, can be from one application to another domain, or from information application to utilization. Technology transfer is associated with research centres or institutions established for such responsibilities (Onyenekenwa, 2010). Generally, technology transfer in the Asian tiger countries usually involves the movement of foreign technology to their countries using strategies to copy, cram or "steal" and later replicate those technologies through well-equipped laboratories and intensive research activities. These strategies ensure that these technologies can result in products with same qualities like those in the parent countries. In Nigeria however, foreign technologies are transferred through the traditional method of negotiated agreements of technology transfer with owners of the technologies (Harry, 2013).

Technology transfer enables the commercialization of developed technologies for economic growth, revenue generation from innovative ideas and inventions and creating research connections between research institutions and industry. Technology transfer is instrumental to industrial success as it enhances regional economic growth and development (Sagar, 2014; Bozeman, 2000) The main goal of technology transfer activities is to transfer product and production processes between development and manufacturing, and from manufacturing sites to achieve product realization. Technology transfer targets four main areas such as; manufacturing process, control strategy, process validation and ongoing continual improvement (ICHQ10, 2011). Technology transfer has resulted in various forms of inventions especially in the Asian tigers. Countries such as Singapore, Hong Kong, South Korea and Taiwan invest heavily in research and development and technology transfer more than other countries resulting in the production of world leading technological products (Terry, 2013). Some technology transfer strategies deployed by these countries are listed below.

South Korea

In South Korea, the major channels of technology transfer are licensing, foreign direct investment (FDI), trade of capital goods, and intra –firm, inter-firm or inter-government transfer. Other methods employed are policies or incentives to attract multinational companies such as tax-holidays, regulating the activities and performance of multinational companies operating in the country, and thereby, facilitating technology transfer through impactful relationship between multinational companies and local companies. Technology transfer has immensely benefitted South Korea as the country has emerged as one of the region's most vibrant economies. The country has almost eradicated poverty, illiteracy and malnutrition. Gross domestic product (GDP) capital reached $ 1.411 trillion dollars in 2016. In the automobile sector, high quality vehicles such as Hyundai, Kia, and Daewoo have been produced. In the electronics sector, LG and Samsung have received international design awards. South Korean electronic appliances are highly successful

and the country is advancing in virtually all areas of the economy (Terry, 2013).

Singapore

In Singapore, technology transfer is very effective at the university research centers. Deployed strategies include joint R&D projects between university research centers and industries .The objective of technology transfer through the Country's Ministry of Trade and Industry is "To promote economic growth and create jobs, so as to achieve higher standards of living for all" Singapore, at independence from Malaysia in 1965, experienced high unemployment and poverty had a largely illiterate population. However, within 3 decades, through technology transfer and technological advancement, a deep water harbour (an ideal trade location was constructed linking routes from Europe to Australia and the West Coast of America. This boosted the country's trading exploits with a highly developed trade oriented market economy which currently enjoys the privilege of being one of the most liberal economies in the world. As at 2013, Singapore had a GDP of $55, 182 billion, one of the highest in the world (Terry, 2013).

Hong Kong

In Hong Kong, methods of technology transfer involve industry-to-industry collaborative projects, technology licensing and contract services through the Applied Science and Technology Research Institute (ASTRI). ASTRI's technological competence encompasses several domains resulting in a wide range of world class innovations. Hong Kong experienced a rapid rise in the manufacturing industry in the 1960s and decades to follow and through technological innovation and transfer. The textile industry was established to boost its economy while the construction business was also re-vamped. The latter aided the construction of good road networks, schools, hospitals and other infrastructural facilities and services (Terry, 2013).

Taiwan

The Government of Taiwan supported and subsidized the acquisition of international technology to achieve substantial success in technology transfer. The country also pursued R&D activities that would complement technology acquisition and development to ensure success. The policy of technological integration assisted Taiwan to benefit immensely from technology transfer (Wei-Lin, 2012). The late 1960s witnessed a great boost in its economy through transfer of technology by the American Toy Company Mattel. The movement of production activities of the company from Japan to Taiwan spurred technological advancement which resulted in the company producing over half the Barbie dolls made all over the world in Taiwan. Through technology transfer, Taiwan has established thriving high-tech industries where products such as laptops, personal organizers and MP3 players are produced (Frans, 2006).

3.0. Methodology

Secondary data were obtained from FIIRO publications available in the Institute's library. These publications include: research reports, journals, records of technology transfer activities such as contract and sponsored researches, training workshops, collaborations and technical assistance services, among others. The methodology also covered searching online materials using the word "technology transfer" to identify publications on technology transfer. Other aspects searched were technology transfer policy documents and budgetary allocations for research and development for economic advancement of these countries.

4.0. Discussion of findings

Results showed that the major research outputs of the Institute's research and development activities included; processing technologies to process cassava to *garri*, *flour*, *fufu* flour, industrial starch, adhesive, noodles, chips, and flour. Others include technologies to produce instant pounded yam flour, ginger powder, processed fish and meat, smoked fish, breakfast cereals, soy-based snacks, beverages, fruit juice, and palm wine. The Institute also developed Cosmetics products such as laundry soap, body lotion and hair pomade, novel processes to utilize household waste in edible mushroom production was also developed. Other products such as *Zoborodo* or roselle drink, *Kunuzaki* bottling and preservation, vinegar, and "*Pito*" or (*Burukutu*) drink were produced. Processing of intermediate local raw materials to products such as sorghum malt, essential oils (eucalyptus, citronella, lemon oil, etc.), adhesive product from cow bone and gum Arabic were embarked on.

4.1. Technology transfer activities

Apart from its in-house research and development (R & D) activities, the Institute is actively involved in the transfer of its industrial research results to prospective entrepreneurs for commercialization. FIIRO started the transfer of its research results to prospective entrepreneurs in the 1980s and has evolved and adopted some methods of making its research results available to prospective entrepreneurs through the following:

(a) Technology transfer training workshops:
This has been the most popular and effective method by which the Institute has been making its developed technologies available to entrepreneurs. The duration of the training workshops are for periods dictated by the complexity of the technology. Since inception of the organized training workshops in the early 1980's about 5,000 entrepreneurs have acquired in-depth knowledge of the various technologies. These entrepreneurs are scattered all over the Nation in various institutions. Table 1 shows the distribution of the beneficiaries of the training workshops.

Table 1: Summary of Beneficiaries of FIIRO Technology Transfer Training Workshops (2006-2016)

S/N	Technology	Total Number of Trainees
1.	Palm wine Bottling and Preservation	43
2.	Alcohol and Vinegar Production	41
3.	Laundry Soap Production	203
4.	Ordinary and Detoxified Cassava Starch Production	128
5.	Gum and Cassava Starch-based Adhesive Production	76
6.	Fufu Flour Production	36
7.	Poultry Feed from Cassava	16
8.	Body and Hair Pomade Production	235
9.	Food Spreads Production	18
10.	Edible Mushroom Production	167
11.	Electroplating Technology	17
12.	Fruit Wine Production	33
13.	Benniseed Oil Processing	34
14.	Baking from Non-Wheat/Composite Flour	227
15.	Plug Refurbishing Technology	9
16.	Foundry Technology	1
17.	Instant Pounded Yam Flour Production	84
18.	Soy Gari Production	7
19.	Smoked Fish production	38
20.	Essential Oils Production	18
21.	Fruit Juices production	158
22.	Tie and Dye	42
23.	Zobo Drink Production and Preservation	34
24.	Cassava Flour for Bread Baking	106
25.	Cassava Chips production	9
26.	Kunu Drink Production and Preservation	3

Source: FIIRO's Training Workshop Annual Report of Technology Transfer (2017)

The table also shows that up to twenty-six (26) different technological innovations were involved in the training workshops in a span of ten (10) years. The table further indicates that the highest number of beneficiaries (227) was recorded for the training workshop for baking bread from non-wheat/composite flour while edible mushroom production, fruit production as well as laundry soap production also received great interest.

(b) Technical Assistance Service (TAS):
This involves the provision of technical information on process technologies, machinery and equipment manuals to user-industries, and the sourcing or fabrication and installation of processing machinery and equipment for clients and training of client's personnel to use the machineries. Table 2 shows the individuals and organizations that have benefitted from FIIRO's

research outputs in terms of Technical Assistance Services (TAS).

Table 2 indicates that beneficiaries of technology transfer via FIIROs: activities were from various parts of Nigeria including Kano, Kaduna, Oye-Ekiti, Ibadan, Ilesha and Lagos.

(c) Licensing

This involves the transfer of know-how on plant or machinery and process technology with patents owned by FIIRO. Interested entrepreneurs are presented with agreement/contract documents to be studied. The patent document is then made available to the entrepreneurs. Royalties to be paid by the entrepreneur to FIIRO would have been incorporated in the agreement. Some examples of FIIRO patents are listed in Table 3.

(d) Contract research

In making industrial research results accessible to micro entrepreneurs, the Institute conducts research on contract basis, on agreed fees and terms. The fees charged cover use of equipment, consumables, overheads and incidental costs. Research results are kept confidential and communicated only to the entrepreneur. The entrepreneur is expected to have sole ownership of the research result for an agreed period of time (Table 4).

(e) Sponsored research:

The Institute is also involved in sponsored research with international and national organizations. The results are targeted at the sponsors. Table 5 shows some of the sponsored researches carried out by the Institute.

Table 2: Some Beneficiaries of FIIRO Technical Assistance Services

S/N	Company Name	Type of Technical Assistance/Service
1.	Cadbury Plc. Lagos	Sorghum Malt Production
2.	International Breweries Ltd. Osun State	Sorghum Malt Production
3.	Associated Breweries Company (ABS Malt)	Sorghum Malt Production
4.	Glaxo Plc. (Now Glaxo Welcome) Lagos	Dry Milling of Cereals and Legumes into Flours for baby food production
5.	Nigeria Production Company, Kaduna	Dry Milling of Cereals into Flours
6.	Jolly Brothers Ltd. Lagos	Dry Milling of Cereals into Flours
7.	Lisabi Mill Ltd. Lagos	Dry Milling of Cereal and Legumes
8.	Lipton/Lever Brothers. Lagos	Infusion Beverage Drink
9.	Kavitex Nigeria Limited. Lagos	Kaolin Refining
10.	Star Flour Mills (Doyin Industries) Okokomaio. Ojo Road	Dry Milling of Cereals into Flours
11.	Adegbemile Food Ind. Ltd., Oye Ekiti, Ekiti State	Cereal and Pulses Processing
12.	Veritex, Ibadan	Cereal Milling
13.	National Grain Production Com., Kaduna	Upgrading of Corn Flour quality for making Tuwo
14.	Funlay Agro Tek. Ilasamaja. Lagos State	Cowpea Processing
15.	Kano State Government, Kano Dyeing Centre, Kano	Upgrading of Local tech in Dying
16.	Ojokoro-Ifelodun Cooperative Farmers Association, Lagos.	Biogas
17.	Continental Pharmaceutical Limited	Cocoa Butter
18.	Consolidated Agricultural and Food Company, Sango Otta, Ogun State	Processing of Corn grits for Corn Flakes processing
19.	North Breweries Ltd	Sorghum Malt/Beer
20.	Dongo Ekema	Smoked Fish
21.	Iddo Cooperative Farm Settlement	Mechanized Garri
22.	Texa Garri	Mechanized Garri Production
23.	Eddy Bros. Enterprises	Palm wine bottling
24.	Uncle T. Palm Wine	Palm wine Bottling and Preservation
25.	Doyin Group of Companies	Cassava Starch and Chips
26.	Obasanjo Holdings	Cassava Starch and Cassava Flour
27.	Oranseniwo Nig. Ltd., Obada Oko. Ogun State	Palm Wine Bottling and Preservation
28.	M.G. Daniels	Plantain Chips Production
29.	Funlay Foods	Kunu Production and Preservation

Source: FIIRO Record of Beneficiaries of FIIRO's Technical Assistance Services (2016)

Table 3: Some FIIRO Patented Technologies

S/N	Title	Patent No/Date	Date Sealed
1.	Producing Garri from Cassava root	1291547 of 25/5/71	7/2/23
2.	Fermented Food Compositions (Soy-Ogi)	2461 of 15/7/72	2/10/74
3.	Producing Garri from Cassava Root	2455 of 15/7/72	2/9/74
4.	Production by Acid Hydrolosis of Modified starch of reduced viscosity from Cassava Starch for textile sizing, light textile finishing and domestic laundry using the Shavy and Non-Shavy Method	R.P. 3961 of 19/6/80	16/12/80
5.	The Production of Malt from Nigerian Sorghum Grains	RP.3917 of 29/12/77	2/11/82
6.	Instant Pounded Yam Flour	RP.13418 of 27/6/96	22/6/99
7.	Groundnut Dehuller	RP.13526 of 27/6/96	14/10/99
8.	Groundnut Sheller	RP.13406 of 7/6/96	2/6/99
9.	Production of Clarified Fruit Juice from Banana, Guava, Cashew, Apple, Pawpaw and Mango	RP16434 of 17/8/05	22/9/2005
10.	Production of Non Sour Detoxified Cassava Flour	RP.16668 of 3/12/06	13/12/06

Source: FIIRO Records of Partnerships and Collaborations (2010)

Table 4: Beneficiaries of FIIRO Contract Researches and Contract Production Services

Organization	Technology	Types Of Service
Bisco Biscuit company, Ikeja Lagos	Production of "Cocoa biscuit" using cocoa powder	Contract Research
Nasco Company, Otta	Production of decorticated local corn for cornflakes	Production services
Lagos State Ministry of Agriculture	Improved production and standardization of coconut snakes (Chuk-Chuk and Gurundi)	Contract Research
33 Breweries, Otta	Production of Sorghum Malt	Production Service
Guiness PLC		
International Breweries Limited, Ilesha		
Domino Stores limited	Tomato Ketchup/ Sauce	Packaging

Source: FIIRO Records of Collaborations and Partnerships (2005)

4.2. Beneficiaries of Collaborations/ Partnerships

Tables 6, 7, 8, 9 and 10 indicate the various beneficiaries of different collaborations/partnerships resulting from the Institute's technology transfer efforts. They include both international and local organizations. This shows the tenacity of the Institute in handling technology transfer activities.

4.3. Prospects and Challenges of Developed Technology Transfer

4.3.1. Prospects

The prospects of local R&D results generated by research institutions in Nigeria cannot be over-quantified, considering the Nation's massive skilled manpower, numerous home-grown and upgraded technologies, abundant natural resources, and large expanse of arable land (now nigerianspace.org). Some of the prospects of research and development and technology transfer in Nigeria include the following:

a) **Increased revenue generation** (to research institutes, tertiary institutions and the user-public)

Research and technology development institutions including the academia will be able to reduce the "financial stress" on the government by generating revenue which could be spent on further research and development activities, through the sales of blueprints, royalties paid on licences, fees on technological transfer and other forms of assistance and consultancy services to entrepreneurs. The user-public would also be satisfied by being able to generate revenue and profit from the locally acquired technologies, thus resulting in a win – win situation.

Table 5: Beneficiaries of Sponsored Research

Organization	Technology	End Users
British Council/Friends of the Environment	Construction of a 42 cubic meter biogas digester for production of cooking gas	Ojokoro-Ifelodun Cooperative Farmers' Association
Raw Materials Research and Development Council (RMRDC), Abuja	Production of pectinable enzyme and utilization for processing of pulpy fruits	Fruit juices producers
United Nations Industrial Development (UNIDO)	Production of single-cell protein from cassava waste	Producers of enriched Garri
European Union (EU) through World Association of Industrial Technology Research Organization (WAITRO)	Development of Biochemical and Molecular Markers as indices for improving quality assurance in the primary processing of cocoa.	Cocoa processors
EU through WAITRO	Research and Development in quality assurance and fermentation technology for traditional African fermented foods	Producers of locust bean condiment ("iru") and soybean condiment (soy-iru)
EU through WAITRO	Biological degradation of aflatoxin from maize and sorghum products	
Food and Agricultural Organization/European Economic Commission (EEC) and Federal Ministry of Science and Technology	Utilization of non-wheat flours for bread making and confectioneries production	Flour Millers, Bakers
World Bank/National Agricultural Research Programme (NARP)	Soybean utilization for the production of instant and semi-instant weaning foods Processing of fruits into shelf-stable products Bottled fruit juices from tropical fruits Production of tomato powder Production of Jams and Marmalades from tropical fruits without adding commercial pectin	Farmers and rural entrepreneurs Farmers and rural entrepreneurs

Source: FIIRO Records of Partnerships and Collaborations, (2010)

Table 6: Collaborators/Partners

CSIR, South Africa
Food Research Institute, Ghana
Forum For Agricultural Research in Africa
Inter Academy Council,
Inter Heritage Promotions
Lagos Chamber for Commerce and Industry
Manufacturer Association of Nigerians.
Motive International
National Association of Small and Medium Enterprises ,Lagos
National Association of Small Scale Industrialist
United Nations Industrial Development Organisations
USAID

Source: FIIRO Records of Collaborations and Partnerships (2014)

Table 7: Collaborators/Partners (Industries)

Alvan Blanch, United Kingdom.
Dangote Group
Flour Mill
Honeywell Group
May and Baker
NASCO Industry
NESTLE Nigeria , Plc
Oxfam Ltd
Unilever

Source: FIIRO Records of Collaborations and Partnerships (2015)

Table 8: Collaborators/Partners (Tertiary Institutions)

Bell. University of Technology , Ota
Covenant University , Ota
Federal University of Agriculture, Abeokuta
Federal University of Agriculture, Akure
Lancaster University, United Kingdom.
University of Central Lancashire
University of Lagos
Yaba College of Technology, Lagos

Source: FIIRO Records, 2012

Table 9: Partners on Techno- Entrepreneurship Development

Yaba, College of Technology, Lagos
Lead City University, Ibadan
Federal University of Technology , Akure
Prime Entrepreneur Development Foundation Lagos
Metropolitan Polytechnic Offa Kwara State
Nigerian Opportunity Industrialization Centre Lagos
Agape Academy Lagos
Believers School of Entrepreneurship Lagos
Centre For Value and leadership Lagos
NEPAD Youth Initiative Lagos

Table 10: Annual Engagement of Students from the following Institutions on Techno-Entrepreneurship

Federal University of Technology Akure, Ondo State
Bell. University of Technology, Ota
Covenant University, Ota
Lagos State Polytechnic ,Lagos
Joseph Ayo Babalola University, Osun State
Yaba, College of Technology, Lagos

Source: FIIRO Records of Partnerships and Collaborations (2010)

Table 11: Nominal GDPs of Nations – Contribution of Industrial Sector January 2005

Country	GDP	Industrial Sector In Percentage	Industrial Sector In Million Dollars
United States	13,632,000	20.4	2,696,880
United Kingdom	2,341,000	25.6	599,296
Japan	4,911,000	25.3	1,242,483
Germany	2,856,000	48.1	831.678
People's Republic of China	2,512,000	48.1	831,678
Nigeria	83,360	53.2	44,348
Malaysia	131,800	48.1	63,396
Ghana	10,180	25.3	2,576
India	796,100	19.3	153,647
South Africa	200,500	30.3	60,752

Source: http://en.wikipedia.org List of countries by GDP sector comparison (2018)

b) Increased gross domestic product (GDP)

Contributions to the Nigerian economy through the productive activities of the indigenous manufacturers/entrepreneurs would boost the contributions to the GDP of the nation in no small measure (see table 11).

c) Increased employment generation

One of the indices of under development is the unemployment index. This will be greatly reduced through investments in home grown technologies from the Research Institutes and Tertiary Institutions as more job opportunities are created. Furthermore, Nigerian graduates would be saved from the "job seeker" syndrome, through

entrepreneurship and technological skill development in their curricula to make them self-employed and job creators (as depicted in table 12)

d) Import substitution and savings in foreign exchange

Home-grown technologies which are designed, researched and created by local scientists, for the people in their own environment are best suited and highly adapted to local conditions. Hence, use of these R&D results (technologies) will forestall the importation of foreign technologies, thus saving the nation loss of revenue in hard currency through import substitution. A very good example of this is the 100% substitution of barley for sorghum in the production of drinks, beverages, sweets and confectioneries, which was developed by FIIRO.

Table 12: Contribution of MSMEs to National Economy of Selected Countries

Country	Employment %
USA	46
India	48.8
Germany	70
Taiwan	-
Shigaro	70
Malaysia	43.7
Korea	-
Japan	80
China	-

Source: http://www.successinyourbusiness.com/smefactor.php Bank Megara, Malaysia (2003)

Also worthy of note is the 10% substitution of wheat flour with high quality cassava flour by FIIRO, amongst many others.

e) Improved innovativeness and productivity

The research community would be further encouraged to conduct more research into the locally available raw materials, when the R&D results are easily transferred adopted and commercialized. This in turn will accelerate economic development.

f) Forestallment of the brain drain syndrome

In view of the current economic issues, there is no better time to stem the tide of losing the best brains and young and sharp minds to the outside world. It is well known that knowledge-driven economies such as the Asian Tigers achieved greater importance in the production cycle than the natural resource-driven economies. Therefore, the skilled human capital which has been developed with hard-earned resources would be saved from the lure of the outside world if the R&D results are readily transferred and adopted for commercial use.

4.3.2. Challenges

Although research and development is carried out by several institutions in the country, including research institutes in general and FIIRO in particular, the academia, conglomerates-industries and individuals, the Institute is yet to fully prove its worth in Nigeria. Often R&D activities in the country are plagued with various constraints which are enumerated as follows:

a) Inadequacy of reliable data

Dependable data are valuable tools when conducting research, especially secondary data, which are needed to study the historical trend in the time series of any subject under research/ past efforts. Unfortunately, the data from national data banks in the country are mostly unreliable, few and far between, thus making research very difficult for the scientist.

b) Inadequate infrastructural support

The inadequacy of infrastructure in the country is also an issue to contend with. Hence, the infrastructural support for the local industries and Research and Development activities calls for attention. This is very evident in the poor state of the road network, erratic power and water supply, and dearth of general utility supply etc.

c) Inadequate funding of government research/allied institutions

This has always been a recurring decimal in that government institutions of research and higher learning are underfunded. Thus, the R&D results often lack the necessary innovation required as a result of the delay in turning out achievements. This is also connected to ill-equipped laboratories in many R&D institutions in the country. Table 13 shows a country-by-country comparison in expenditure on R & D in selected countries. This supports the claim by Nelson (2003) that funding is very important for R&D activities to ensure sustainability and successful research results relevant to the industries. According to Fu and Gao (2007), the Asian economies adequately financed R&D activities in their research institutions.

Table 13: Expenditure on R&D as Percentage of GDP

Country	Percentage of GDP
Sweden	3.8
Canada	1.7
United States of America	2.5
Japan	2.8
Israel	3.7
Korea (Rep)	2.9
Togo	8.4
Nigeria[	0.1
Uganda	0.8

Source: Human Development Report – UNDP (2002)

d) Stiff competition from cheaper foreign goods

The influx of imported products into the Nigerian economy has not helped in assisting local R&D activities, to make much impact on the economy. These imported goods are cheaper (though often substandard), and readily available compared with the locally developed/produced products which are more expensive and often of a better quality e.g., Nigerian Wires and Cables. However, this competition has robbed the country of the necessary impetus required to propel the wheel of progress for local R&D to move forward as expected. In developed countries, business activities of foreign companies are monitored while the reverse is the case in Nigeria.

e) Lack of awareness for developed technology results

The marketing of research results which would otherwise have helped create awareness and attract potential users is not well attended to. As a result of this, the end results of most research efforts (technologies) often end up on the book shelves of researchers and institutions or file of policy makers. The development of any nation through technology utilization can be impaired in this respect (FMST, 2004).

f) Lack of adequate political will and support

Often times, government policy somersaults have truncated the efforts of R&D geared towards oiling the wheel of economic development and growth. For instance, the expected legislation on the 10% cassava flour inclusion in wheat has suffered a serious setback, thus causing untold hardships for investors and all stakeholders, especially producers of High Quality Cassava Flour. This has generated a "once bitten, twice shy" attitude of investors, thus making it more difficult to transfer locally developed technologies to potential investors.

g) Poor remuneration of R&D and academic personnel:

The low remuneration of government research and academic staff has often led to incessant strikes and other forms of industrial action. This has caused delays in turning out research results and has also contributed to the low morale of such personnel. This may slow down R&D contributions to the economy.

Policy Implications /Conclusion

The importance of the impact of technology transfer is instrumental to the astronomical development being witnessed among the Asian tigers and other developed countries around the globe. It should be noted that these countries invested heavily in technology transfer and R&D to ensure appropriate utilization of acquired technologies by industries. Nigeria should strengthen her research institutions in terms of adequate funding, infrastructural facilities, and remuneration of research personnel in the universities, polytechnics and research institutes to allow serious engagement in the transfer of developed research results for urgent national development.

References

Adeyemo, F. S. (2008) Assessment of the Transfer and Commercialization of Research and Development Results by Research Institutes in South Western Nigeria. MSc. Thesis for Obafemi Awolowo University, Ile Ife pp 9-10.

Adeyemo, F. S., Odediran, O. F and Ogundeji, R. K. (2004). The Roles of Research Institutes, Government and Public Sector in Maximizing the Social and Economic Benefits for Public Investment in Research and Development: The Way Forward. A Paper presented at the workshop organized by Independent Policy Group, Abuja. pp 5-7.

Ake, C. (1984). A Political Economy of Africa, New York, Longman Inc

Bozeman, B. (2000). Technology Transfer and Public Policy: A Review of Research and Theory. *Research policy* 29.

Emeagwali, P. (2010). Africa Must Innovate or Perish. Nigeria News and World Affairs on Nigerians Abroad Live.com.

FIIRO (2013). Entrepreneurship Development in Nigeria (Some Beneficiaries of FIIRO Contract Researches and Contract Production Services as at 2005) Yaba, Lagos, CIBN, p 33.

FIIRO (2013). Entrepreneurship Development in Nigeria. (Some FIIRO Patented Technologies as at 2010) Yaba, Lagos, CIBN, p 29

FIIRO (2013). Entrepreneurship Development in Nigeria. (Beneficiaries of Sponsored Researches as at 2010) Yaba, Lagos, CIBN, pp 33-34.

FIIRO (2010). Records of Partnerships and Collaborations File, Techno-economics and Techno-entrepreneurship (TET) p 50.

FIIRO (2010). Records of Partnerships and Collaborations (Annual engagement of students on Techno-entrepreneurship File, Techno-economics and Techno- entrepreneurship (TET) p 60

FIIRO (2012). Records of Partnerships and Collaborations (Tertiary Institution} File, Techno-economics and Techno-entrepreneurship (TET) p 68.

FIIRO (2014). Records of Partnership and Collaboration File Techno-economics and Techno-entrepreneurship (TET) p 132

FIIRO (2015). Records of Collaborations and Partnerships (Industries) File Techno-economics and Techno–entrepreneurship Division (TET) p 147.

FIIRO (2016). Record of Beneficiaries of FIIRO's Technical Assistance Services in the Compiled Report on FIIRO's Technology Transfer Activities FIIRO (2017). Training Workshop Annual Report of Technology Transfer Division 27-28, FIIRO (2016). Record from Partnerships and Collaboration's File, Techno-economics and Techno-entrepreneurship (TET)

FMST (2004). A Compendium of on-going Research and Development Projects in Research Institutes under the Federal Ministry of Science and Technology Frans A Van der Zee (2006). New Asian Growth Dynamics in the Context of Globalization, p18

Fu, X., and Gao, Y. (2007). Export Processing Zones in China: A Survey. A Report submitted to International Labour Office.

Harry, D. M. (2013). Research, Technology Transfer and Social Economic Development in Nigeria: Some Lessons from the Asian Economies Mediterranean *Journal of Social Science* 4(3), 119-123.

https://en.wikipedia.org Accessed June 15, 2018 (List of countries by GDP comparison)

https://www.successinyourbusiness.com/smefactor.php Bank Megara, Malaysia, 2003

https://data. Worldbank.org>indicator (Human Development Report – UNDP, 2002)

https://www.statistca.com. Accessed 20/10/2018.

ICHQ10 (2011). Pharmaceutical Quality Systemwww.Org Q10_General_Presentation (Guidelines for Technology Transfer).

Ilori. M. O. (2006). From Science to Technology and Innovation Management: Inaugural lecture series 191. Obafemi Awolowo University Ile- Ife May 29, p 11

Ilori. M. O. (2010). Technical Entrepreneurship Development. Paper presented Yaba College of Technology. Pp 1-2

Koleoso, O. A. (1987). Problems and Prospects of Commercialization of Research Results: A Paper presented at the National Conference University, Research Institutes and Industries: Partnership and Technological Development by the National Universities commission, University of Port-Harcourt pp 5-7.

Lundquist, G. (2003). A Rich Vision of Technology Transfer and Technology Value Management. *Journal of Technology Transfer*, 28(3 -4), 284

Nelson, L. (2003). The Role of University Technology Transfer Operations in Assuring Access to Medicines and Vaccines in Developing Countries. *Journal of Health Policy, Law and Ethics,* 3(2), 302

Onyenekenwa, C. E (2010). Technology transfer adoption and integration : A Review *Journal of Applied Science* 10(16): pp 1814-1819

Olatunji, O. (2001). Research and Development Activities at FIIRO, A Paper presented for Chemistry Students at Federal Polytechnic Bida. January 22, Lagos pp 7-8.

Ramanathan, K. (2009). An Overview of Technology Transfer Models. A paper prepared for the Asian and Pacific Centre for Transfer of Technology.

Sagar, P. (2014). Review Article on Technology Transfer. *International Journal of Pure and Applied Bioscience*, 2(3), 145-146.

Terry, Y (2000). Re-Assessing the Health of the Asian Tigers. *Journal of Global Business*, 3(1), 48

Wei-lin Wang. (2012). Review of the Legal Science and Practice of Technology Transfer in Taiwan. INTUT *Journal of Intellectual Property, Law & Management,* pp 200-207.