BENCHMARKS FOR RESEARCH FOR THE GENERATION OF EXPLOITABLE INTELLECTUAL PROPERTY

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ABSTRACT

Although Nigerian research sector can boast of a large number of institutions, the generation of exploitable Intellectual Property (IP) has been low. This can partly be blamed on paucity of research funds and low capacity of researchers and research institutions in attracting meaningful research grants that will enable them have adequate research infrastructure. In order to create the enabling environment for exploitable IPs, Universities should consciously form Research Groups (RG) which will eventually blossom into Centres of Excellence in selected fields. Such groups can develop research projects that will meet with standard benchmarks for exploitable IPs.

The benchmarks for research for exploitable IPs include: capacity and capability for high impact research, high quality research output including patents, publications in high impact journals, research that address critical national, regional and global issues, spinoffs and commercialized products and services, research teams that include researchers and industry collaborators across different universities, industry and countries and attraction of significant project funds.

The role of government, universities, industry and researchers in achieving these are discussed. For Government, there should be a functional policy to promote IP exploitation and more investments in Research through the actualization of the proposed National Research and Innovation Fund. For Universities, there should be a paradigm shift towards Entrepreneurial University concept to ensure that researchers have access to adequate facilities and technology transfer. For industry, there is need for more collaboration and support for research. Researchers should be entrepreneurial, pursuing only those research that lead to exploitable IPs. This implies forming research teams that address critical national, regional and global issues and the teams should have membership drawn from different relevant disciplines, different universities and industry.

1. INTRODUCTION

By every available index of measurement, Nigeria is poor in innovation, competitiveness and production of goods and services driven by modern technology (Ariyo, 1999; Adeoti, 2007; Siyanbola et al., 2012; Onwualu, 2014abcdef). This translates into an economy that is vulnerable to external shocks; poor infrastructure (roads, maritime, electricity, water, aviation, healthcare,

education, housing, urban development, environment, communication); poverty and general low standard of living (COREN, 2014; Bogoro, 2014). A closely related consequence of these is the prevalence of conflicts between different socio-economic, ethnic and religious groups.

This apparent state of hopelessness is at variance with the rich natural resource endowment of the country. Nigeria is blessed with crude oil but most of it is exported in raw form while refined petroleum products are imported into the country. In addition, the country has over 40 minerals and 50 agricultural resources in commercial quantity (Onwualu, 2009; Onwualu et al., 2012; 2013abc; RMRDC, 2011; Mejabi and Gimba, 2014). Yet the country imports processed food products and industries import intermediate raw materials that are derived from these resources through value addition. A good example is tomato. Nigeria produces large quantities of tomatoes, yet different processed tomato products are imported into the country (Ugonna et al, 2015). Although at least two large scale plants for processing the product were recently commissioned by the private sector, this importation continues. The service and commerce industries including tourism, communication, sports, education, healthcare and trading seem to be flourishing but they are also based on imported goods and services (Onwualu et al., 2013b). Therefore, the major source of foreign exchange and government revenue is sale of crude oil. Currently, the economy is on its knees and the local currency (Naira) is under pressure because of dwindling oil price.

It is believed that the economic problems facing Nigeria can be resolved if the local content of all sectors are systematically increased on a continuous basis. This means producing as many goods and services as possible locally by adding value to the natural resources. This requires investment in technology and infrastructure that are more on-shore than off-shore. It also means that there must be a robust National System of Innovation that encourages formal and informal research to generate and deploy innovations in all sectors to create wealth. Of course, all these require functional infrastructure including: electricity, transport, security, engineering and technology, business environment and finance. This can only be successful if there is a strong and effective Intellectual Property (IP) regime to protect the rights of inventors of knowledge.

But for inventions to occur, there must be research (formal and informal). This is why some school of thought lays the blame for inability of Nigeria to use technology for development at the door step of the Knowledge Centres (KC), led by Universities. Are researchers living up to expectations? If not, why and what needs to be done?

In this paper, we outline the status of research in Nigeria, discuss the challenges facing research in Nigeria and suggest benchmarks for the type of research that can generate exploitable IPs. Finally, the role of relevant stakeholders (government, universities, researchers, industries) in entrenching and sustaining such research are discussed. It is believed that these suggestions if implemented can lead to a regime of continuous generation of exploitable IPs and hence sustainable economic growth in Nigeria. In the discussion, I will use case studies that I am familiar with but there are other examples from all over the country.

2. INTELLECTUAL PROPERTY (IP)

The world economy is based on the production, distribution, transportation, sale and marketing, consumption of goods and services to satisfy the needs and wants of the growing number of urban dwellers and globalized world. The needs and wants include food, shelter, clothing, education, healthcare, transportation, entertainment, sports, security, communication, waste management, etc. To achieve these we need to apply knowledge and technology to solve problems. Although most general knowledge are in the public domain, tacit knowledge and new knowledge have to be protected at least for some time in order to allow those who invented or developed them to enjoy the profits emanating from them for some time before they are made public. The new knowledge, product or service or invention is referred to as Intellectual Property IP (Ofili, 2014; Okeke and Uzor, 2014; Onwualu, 2013).

Intellectual Property can be classified into two namely Industrial Property and Copyright. Industrial Property includes patents, trademarks, designs, geographical indicators, scientific discoveries, protection against unfair competition, etc. Copyrights include literary works such as books, plays, films, music, artistic works, paintings, drawings, photographs, websites, etc. Intellectual Property is important and must be protected by laws (Ogunkeye, 2013; Kameri-Mbote, 2005; UNESCO, 2015). Within the period of protection, the inventor has the sole right and monopoly to enjoy the proceeds of the invention. This fuels more inventions and hence economic growth as individuals, institutions, industries are encouraged to continuously innovate through IPs. In this way, humanity is sustained as more new goods and services are introduced on a continuous basis, each new product being better than earlier ones. For example, photography, telephony, video, calculator, computer, television, document sharing, etc were separate technologies before now. Today, all these and even more are integrated into one product – Mobile Phone. Although most components of technology of mobile phones are in the public domain, most of the hardware and software driving the service are protected as IPs and the IP holders are enjoying the fruits of their labour. This has continued to encourage the rat race in developing new applications every day. Today there are applications for banking, shopping, bill settlements, healthcare, education, agricultural and weather information, all in the GSM Phone and they are all protected by IP laws.

As important as IP is, not all IPs are useful and exploitable. For an IP to be exploitable, it must have the potential of being converted to wealth. The main characteristics of exploitable IP include: new and novel; useful to society; must lead to a product or service; potential for scale up and commercialization; non obvious; must not have been disclosed; must have scientific basis and so reproducible and can be described, should not be shrouded in mystery; must have competitive advantage to existing alternatives. However, it is important to encourage production of IPs whether they are exploitable or not. This is because, in general at least 30% of IPs

worldwide end up creating wealth directly or indirectly. This means that the more IPs you have as a country, the more likely there is chance of exploitable IPs.

Table 1 shows an extract of a list of individuals with highest number of patents in the world (Wikipedia). Incidentally, the same countries also come tops in other IPs such as books, software etc. Table 2 shows different IPs that have been developed over the years. It is instructive to note that almost all countries with high turnover of IPs have the following characteristics: high number of World Class R&D centres, especially universities, high investment in Knowledge generation and research, high number of high tech companies, venture capital companies, ready access to technology and finance, good and functional Research-Industry collaboration. It is obvious that these are lacking in Nigeria and that is why we have fared very poorly in generating and using IPs.

It is important to note is that it is these countries that have high and continuous turnover of IPs that are developed and industrialized, with high standard of living, driven by the type of products of high technologies shown in Figures 1-10 for different sectors (Onwualu, 2015ab). Another interesting thing to note about innovations and by extension research and IP is that the time required to move from one invention to the other is getting shorter and shorter as shown in Fig. 11 (Hargroves and Smith, 2005). The figure shows that from the era when steam engine, textiles were discovered to the present when digital systems and green technologies are being discovered, more innovations and inventions are coming out in less time. The implication of this is that Nigeria must brace up and join the rest of the world in developing and using IPs, otherwise the country will continue to be a consuming nation with the unfortunate situation of ever dependence on other economies. The chart (Fig. 11) shows that between 1785 and 1845 (60 years), the first wave of innovations occurred including iron, water power, mechanization, textiles, commerce. The second wave of innovations occurred between 1845 and 1900 (55 years), with a higher peak and included steam power, rail road, steel and cotton. A higher peaked 3rd wave of innovation occurred between 1900 and 1950 (50 years) and included electricity, chemicals, internal combustion engines, etc. The 4th wave of innovation with a higher peak occurred between 1950 and 1990 (40 years) and included petrochemicals, electronics, space, aviation. A much higher peak with shorter time duration occurred between 1990 and 2000 and included digital networks, biotechnology, software and information technology. The 6th wave (2000 – date) is still evolving and includes sustainability, green technology and green energy, nanotechnology etc. All these are driven by IP.

When IP is properly harnessed and exploited by a country in a consistent manner, it leads to high ranking on Global Innovation Index (GII) because the country would have scored high on the relevant pillars of the Index. Table 3 shows that the countries with high GII include Switzerland, Netherlands, USA, Japan, India, Australia, Canada, etc. Nigeria is a distant 110 out of 141 countries. For Nigeria to improve on her GII ranking, there must be innovations which can only happen if there is a good IP regime in all sectors. This in turn depends on cutting edge Research. In the next section, we shall discuss the status of research in Nigeria.

Table 1. Individuals and countries with highest number of inventions.

Name	Number of Patents	Country
Kia Silverbrook	4732	Australia
Sunpei Yamazaki	4388	Japan
Paul Lapstun	1278	Australia
Lowell Wood	1265	USA
Gurtej Sandhu	1217	India
Jun Koyama	1155	Japan
Leornard Forbes	1088	Canada
Thomas Edison	1084	USA
Roderick Hyde	1046	USA
Donald Weber	999	USA
George Lyon	993	Canada
John O'Connor	949	USA
Melvin DeGroote	925	USA
Francis Richards	894	USA
Shou-Sha Fan	745	China
Artur Fischer	696	Germany
Bela Bereny	595	Austria
????	????	Nigeria

Source: Wikipedia, list of prolific inventors.

Table 2. Examples of products from Exploitable IPs

Economic Sector	Products from IP
Education	Pencil, pen, paper, ink, books, writing, chalk,
Entertainment	Music, dancing, video
Transport	Car, lorry, trucks, tankers, SUVs, buses, airplane, helicopter, train, ship,, canoe, bicycle, airport, .
Manufacturing	Drills, welding machines, electrodes,
Consumer Electronics	Refrigerator, air conditioner, fan, rechargeable lantern, water dispenser, freezer, radio, television.
Healthcare	Hospital, X-ray, scanning machine, drugs,
Sports	Football, soccer, monopoly, scrabble, golf, cricket, baseball,

Housing	Cement, concrete, tiles, roofing sheets, blocks.
Food and drinks	Malt, beer, whisky, red wine, soft drinks, fruit juice, bugger, meat roll, fish roll, cake, bread.
Agriculture	Tractor, herbicide, pesticide, fertilizer, seeds, storage, rice mills, crushers, dams, irrigation, soil conservation, post-harvest technology..
Industrial Chemicals	Acid, paint,
ICT	Internet, computer, printer, telephone, GSM, satellite,
Banking	Money counter, ATM, cheque, money transfer,
Power and Energy	Electricity, OLED, transformer, solar cell, battery, engine, wind mill, transmission lines.

Table 3. Global Innovation Index (GII), 2014 ranking

Ranking	Country	Percent score	Ranking	Country	Percent Score
1	Switzerland	64.78	10	Hong Kong	56.82
2	UK	62.37	21	Japan	52.41
3	Sweden	62.29	29	China	46.57
4	Finland	60.67	53	South Africa	38.25
5	Netherlands	60.59	78	Tunisia	32.94
6	USA	60.09	85	Kenya	31.85
7	Singapore	59.24	96	Ghana	30.26
8	Denmark	57.52	109	Burkina Faso	28.18
9	Luxemburg	56.86	110	Nigeria	27.76

Source: WEF 2014.

Fig. 1. Large scale industry – product of innovation

Source: www.globalsofttechnology.com/industry.php. www.cbm.com.sg/Industries

Fig. 2. Beverage manufacturing

Fig. 3. Making of cars – innovation

http://www.fotosearch.com/CSP009/k19844106/

Fig. 4. Cement manufacturing plants

Fig. 5. Industry, making innovations work.

Fig. 6. Innovations in aviation

Fig 7. Innovations in train service. http://ehailakandi.com/train-from-hailakandi-to-guwahati/

Fig.8. Innovations in mechanized agricultural production.

http://www.canstockphoto.com/images:dhttp://www.shutterstock.com/

Fig. 9. Hospital equipment http://medical-equipment-parts.blogspot.com

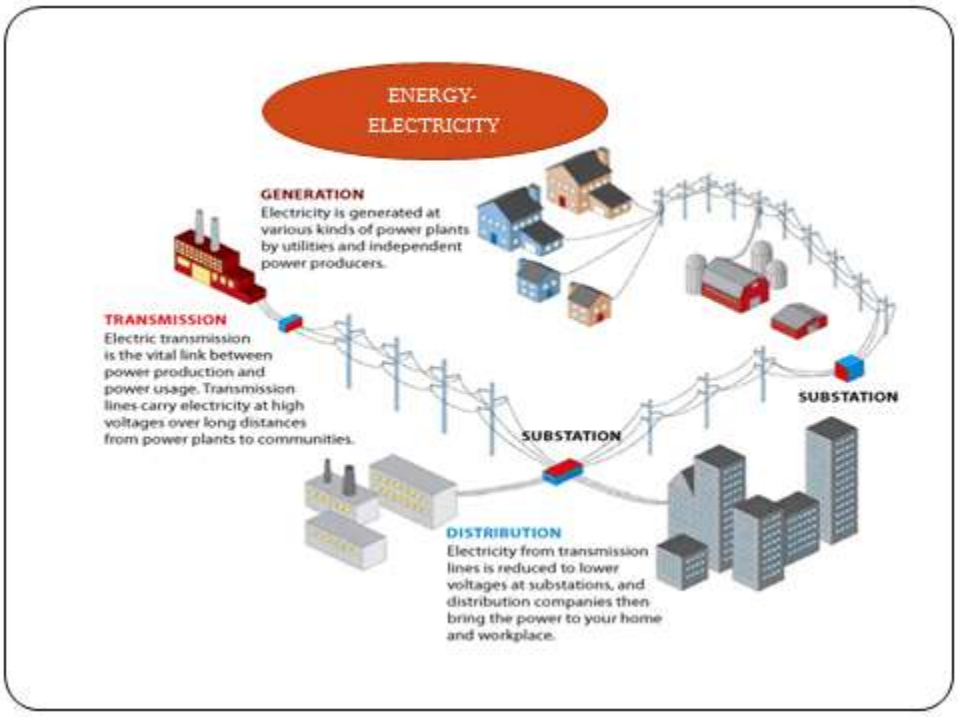

Fig. 10. Electrical energy production innovation. http://www.incontext.indiana.edu/

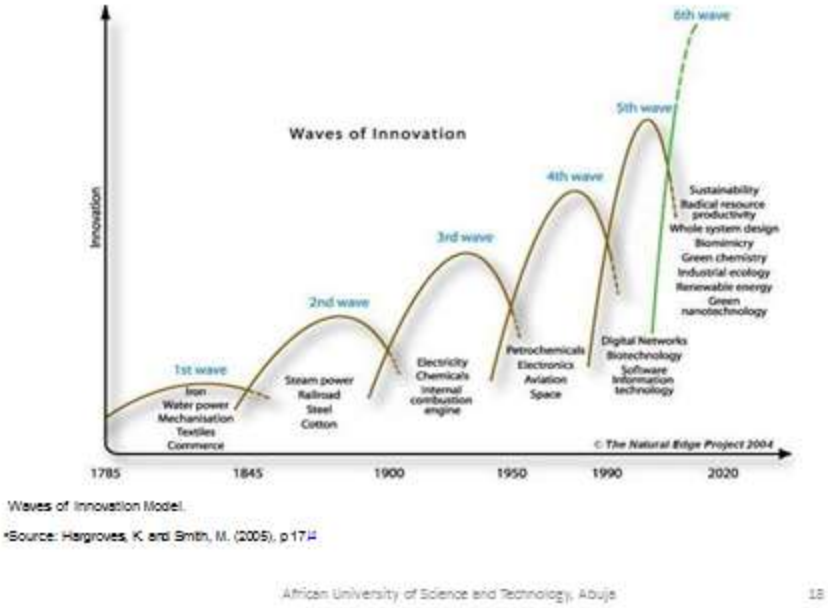

Fig. 11. Waves of innovation (Hargroves and Smith, 2005).

3. RESEARCH IN NIGERIA

The historical development of research in Nigeria has been captured by various publications (Awe and Oluwole, 1992; Momah, 1999; Animalu and Adekola, 2002; Iweriebor, 2004; Siyanbola et al, 2014; Okon, 2013; Onwualu, 2014; Onwualu and Ugonna, 2015). Several policies have been formulated and implemented over the years (Onwualu, 2006; Ajoku and Onwualu, 2012; FMST, 1986, 2012). The major Research Policy currently in operation is the National Policy on Science, Technology and Innovation. This covers almost all Science and Technology based sectors and is implemented by the Federal Ministry of Science and Technology (FMST). However there are also sectorial research policies formulated and implemented by several ministries. These include: Ministries of Agriculture, Industry, Health, Education, Arts, Culture and Tourism, etc. Recently an attempt at bringing the research community together resulted in the establishment of the National Research Coordinating Council chaired by the President, with secretariat at Federal Ministry of Science and Technology (FMST).

The various policies have given rise to an apparently large number of Knowledge Centers (KCs) where some form of research is done. Table 4 shows that research in Nigeria is done in Universities, Research Institutes, Polytechnics, Colleges of Agriculture, Education, Enterprise Innovation Institutes, Industries, International Research Centers and Informal Centers. Details of these are given by Onwualu and Ugonna (2015). In terms of numbers, this appears impressive but when compared to a total population of 170 million people, this is not adequate. In addition,

there is evidence that but for the recent intervention of TETFund in the educational sector, laboratories, research funds and other Research Infrastructure have not been at their optimum.

Table 4. Knowledge Centres in Nigeria

S/No	Type of institution	Number (2016)
1	University	142
2	Polytechnic	95
3	Monotechnic	27
3	College of Education	83
4	College of Agriculture	36
	College of Health Technology	50
5	Research Institutes (National)	65
6	Research Institutes (International)	3
7	Vocational and Enterprise Innovation Institutions	135
8	Technical Colleges and Training Centres	132
9	NGOs, development partners, foundations	> 100
10	Informal sector (inventors, SME fabricators, trade clusters)	> 2 million
11	Large scale manufacturing industries	> 500
12	Professional and academic bodies such as Nigeria Academy of Science, Nigeria Academy of Engineering, pharmaceutical Society of Nigeria	20

Source: NUC Newsletter, NBTI, NCCE, Onwualu and Ugonna 2015.

Table 5 shows that the institutions that are involved in research funding in Nigeria include: Tertiary Education Trust Fund (TETFund), Agricultural Research Council of Nigeria (ARCN), Raw Materials Research and Development Council (RMRDC), National Information Technology Development Agency (NITDA), National Office for Technology Acquisition and Promotion (NOTAP), Large Scale Industries, Development Partners. The proposed National Research and Innovation Fund is yet to take off. In terms of magnitude of funding, whereas countries such as US, Japan, spend up to 10% of their GDP on research and development (R&D), Nigeria spends less than 1%. The low investment in R&D has resulted in the low

performance of the research sector. All parameters shown in Table 6 indicate poor performance of R&D in Nigeria.

As one researcher put it, some of the negative characteristic of research in Nigeria include: poor linkages between research and end user; weak research industry linkages, weak dissemination of research results, poor commercialization, exodus of outstanding researchers, paucity of research funds, inadequate research infrastructure, poor linkages with global research community, poor impact on economy and poor incentives and motivation ((Egwunyenga, 2008).

The current situation in Nigeria provides an array of opportunity for improving the research sector towards producing exploitable IP. These include: the current directive by NUC for universities to upgrade their institutional arrangement for promoting R&D; Support of NOTAP to Universities to establish IP offices, current challenge of dwindling oil price, current wave of interest in economic diversification, promotion of made in Nigeria goods, improved funding from both government and industry. It is therefore imperative that operators in the research sector should brace up to revitalize the research sector by fostering the emergence of world class research centers and groups who can generate the type of IPs that can be exploited for economic development.

Table 5. Research Funding Agencies in Nigeria.

S/No	Name	Acronym	Area of Focus
1	Tertiary Education Trust Fund	TETFund	Almost all sectors including commercialization and research infrastructure.
2	Petroleum Technology Development Fund	PTDF	Research related to Petroleum exploration and processing.
3	Agricultural Research Council of Nigeria	ARCN	Agriculture
4	Raw Materials Research and Development Council	RMRDC	Raw materials
5	National Information Technology Development Agency	NITDA	ICT
6.	National Office for Technology Acquisition and Promotion	NOTAP	Technology transfer
7.	National Automotive Council	NAC	Automobile technology
7.	Development Partners (World bank, British Council, DFID, USAID, IFAD).		All sectors
8.	Large Scale Industries	NLNG, Dangote,	Manufacturing, raw

		TOTAL, Flour Mills, etc	materials

Table 5. Performance indicators for Research in Nigeria (poor, fair, good)

Parameter	Poor, fair, good
Number of PhDs produced annually	Fair
Capacity building of research staff	Poor
Number of patents produced	Poor
Spin offs and commercialization of research results.	Poor
Publications in very high impact journals (Nature, Science)	Poor
Research Industry Linkage	Poor
Products and services in industrial sector supported by research.	Poor
Relevance of research to industry	Poor

4. BENCH MARK FOR RESEARCH FOR GENERATION OF EXPLOITATABLE IP

As noted earlier, an exploitable IP must be: new; novel; commercializable; non obvious; must lead to a useful product or service, have scientific basis, and must have a competitive advantage over existing IPs. The type of research that can generate such IP cannot happen by accident. It must be planned, implemented and sustained. The bench marks discussed below can be used to develop a research regime that can generate exploitable IP.

Research Capacity and Capability

For the system to be able to produce exploitable IP, there must be a robust research capacity and capability. There should be adequate research facilities namely modern library, well equipped workshop and laboratory. ICT infrastructure including good bandwidth. There should be standing research groups that will blossom into Centers of Excellence with capacity and capability to respond to critical national, regional and global issues through research. These include issues such as elections, conflicts, energy, climate change, value addition to natural resources, health care (organ failure), materials, etc.

Research Output

The research groups set up should aim at cutting edge research, producing high quality publications including books and journals published by high impact publishers; producing patents; high quality research proposals; research that has high impact on industry, research - industry partnership spinoffs and commercialized research results. From the beginning, these benchmarks must be used to set targets and deliverables. Such groups must be in touch with their peers in the field in World Class universities, active in international conferences and electronic discussion groups and well informed scientifically.

Research Funding

Research Groups should consciously hunt for grants from universities, national bodies, international grant awarding institutions and from industries and foundations. This implies writing winning proposals and requires serious capacity building of researchers and ensuring relevant information that will aid development of winning proposals. The University should consider setting up a special office to assist researchers in battling with the difficult terrain of winning proposals.

Grants Winning Proposals

Research that can generate exploitable IP should be preceded by a high quality proposal. Such a proposal should look at the big picture covering capacity building such as training PhDs modeling to develop new predictive equations, extensive empirical and experimental studies or surveys and designs to generate new ideas, technology or devices that are patentable and commercializable. Such research will look at cultural, scientific, economic and socio political aspects of the problem. Such a research can only be done by multi-disciplinary groups made up of scientists, engineers, economists, sociologists etc. all working as a team. They should address topical issues and should have linkage with other researchers both regionally and internationally. Thus research that address problems across national boundaries are preferred. Most grant awarding bodies will check for scientific content, possibility of breaking new ground, potential patents, clarity of writing, potential impact on the economy, nationally, regionally and globally, environmental sustainability and gender dimensions, business models for commercialization and dissemination of results.

Research with End User Collaboration

For research to produce exploitable IPs, there must be linkages with end users. In fact there is no reason why student projects should not be done to solve industry problems. For this to happen the research group must cultivate the collaboration of end users namely industries, MDAs, NGOs, SMEs. There can even be joint supervision of projects with industry operators. In order to elicit the interest of industries, research must seek to increase competitiveness, profits and business opportunities for industries. Close relationships with industries can be cultivated through joint seminars, exhibitions, public lectures by industrialists.

Research Administration

For all the above to happen in a sustainable manner, there must be good environment for research. Most Universities realize this now and that is why some have created Directorates of Research directly under the VC's office to coordinate research in the entire institution and assist in raising funds, linkages with industry and filing patents. Some have established University Enterprises while some have established Industrial Parks or Knowledge Parks. Such offices help to ensure that researchers have access to good research facilities by attracting support for laboratories, workshops, ICT facilities, etc. Others have established Technology Transfer Offices to help in Research results dissemination. Conscious efforts should be made to establish Centres of Excellence.

5. CASE STUDIES OF RESEARCH FOR EXPLOITABLE IPs

A few cases shall be used to illustrate the type research that can generate exploitable IPs. Four of the projects are selected from the projects funded by the Raw Materials Research and Development Council when the author was the Director General and one from the African University of Science and Technology. There are other examples all over the country.

Case Study 1: Fruit Juice Concentrate Project

This was a project sponsored by World Bank Step B hosted by RMRDC. It was aimed at promoting the value chain for fruit juice concentrates. Most of the fruit juices we drink in Nigeria are made from concentrates that are imported. We are talking about millions of litres worth billions of Naira annually. The project was aimed at removing all the bottlenecks to making concentrates in Nigeria. The team leader was RMRDC with collaborators including some research institutes: National Biotechnology Development Agency, NABDA; Nigerian Horticultural Research Institute (NIHORT) and private Companies (FUMMAN Agricultural Products and Niger Resources Ltd). The project upgraded tissue culture technology laboratories in NABDA and NIHORT and promoted backward integration among Fruit Juice making companies in Nigeria.

Case Study 2: Cashew Processing Project

This was a project to commercialize cashew processing technology developed by two Universities – Kogi State University Anyagba and University of Agriculture, Abeokuta. The project was sponsored by RMRDC with the two Universities providing the knowledge and RMRDC providing processing equipment. A private company ABOD Success Ikorodu, was involved. The processing factories built by the two universities are processing and packaging cashew nuts today. This is another example of Professors, business men and women, government agencies and financial institutions working together,

Case Study 3. Moringa Development Project

This project was aimed at developing the value chain for the medicinal plant Moringa. Sponsored by the RMRDC, this involved some researchers from some Universities, some SMEs and research institutes. The Universities were involved in developing technologies while the SMEs applied the technologies in production of different products including Moringa oil, seed powder, tea, soap, milk etc. A Moringa Development Association was formed made up of academics, government and industrialists. The empowered SMEs are currently producing different Moringa based products. The research team was made up of researchers, research institutes and SMEs.

Case Study 4: Pan African Materials Institute (PAMI)

The Pan African Materials Institute (PAMI) is one of the 9 World Bank assisted Africa Centres of Excellence (ACE) Project won by the Materials Science Group at African University of Science and Technology (AUST), Abuja. The project seeks to solve the problem of inability of Africa to add value to materials by pushing the frontiers of Materials Science and Engineering, training of post graduate students and developing and deploying technologies in three areas: energy, biomaterials and multi-functional materials. The team is a multi-disciplinary one. The project is based at AUST but has partners in various universities (including NAU), research institutes and industries both within Nigeria and outside. The project offers scholarships to outstanding MSc and PhD students with preference to women from all over Africa. It also includes short term training and laboratory development. So far research has produced a number of PhDs with patentable and commercializable IPs in the area of LEDs, implantable devices, waters filters, etc.

Key to Success of the Projects

These projects succeeded for a number of reasons. These include: adequate funding for capacity building and research, collaborative spirit and multi-disciplinary teams cutting across institutions and industry, protection of IP, relevant skills, good business and marketing models, serious effort at commercialization, topical issues to address real industrial problems, looking at the big picture, ranging from research, product development, marketing etc.

6. WAY FORWARD: ROLE OF STAKEHOLDERS IN FOSTERING CUTTING EDGE RESEARCH

In order to foster research that can generate exploitable IPs, four groups of people must be involved. These include: Government, Industry, Universities and Researchers.

6.1 Government's Role

Government, through statutory bodies such as Federal Ministry of Education, State Ministries of Education, National Universities Commission (NUC), Tertiary Education Trust Fund (TETFund) should sustain current efforts at reforming the system by introducing more innovative

programmes as well as making sure that the efforts already in place are reinforced especially in the area of funding (Coccia, 2007; Onwualu, 2013; Sawyer, 2004). There should be a policy to transform selected universities to Research and Entrepreneurial Universities, with all the implications (Anya, 2008; Dooley and Kirk, 2007; Chikwe et al, 2015; Bogoro, 2014; Wu, 2007; Hannon, 2013; Onwualu, 2014; Clark, 1998; Etzkonitz et al., 2000). Training should be provided for university administrators using the criteria already discussed on how to assess research output. A number of Government Agencies, Parastatals, including research institutions can also work with universities towards research. Some of these agencies have projects which can be handled by universities and their researchers. The best model to adopt is to put up teams made up of researchers from universities, research Institutes, industries including SMEs.

6.2 Role of Universities

Every university needs to undergo reform towards the paradigm shift to Research and Entrepreneurial University (Bako, 2005; Clark, 1998; Onwualu, 2015, Etzkowitz et al., 2000). Some of the steps that should be taken include: Institutional paradigm shift through strategic planning; retraining of principal officers and some change agents; internalizing research and innovation in departments, schools and faculties; creating and strengthening Centers of Innovation, Research and Entrepreneurship in different areas; formation and encouragement of research groups, strengthening dissemination including: publications, Journals, workshops, exhibitions, spin offs, web presence; assisting researchers to have access to research funds, cultivating research –industry linkages, establishing industrial parks, periodic evaluations beyond accreditation by NUC and professional bodies and encouragement of patent registration (Okebukola, 2004; Eluede, 2009; Asiabaka, 2006; Brunnel et al., 2010; Nwekeaku, 2013; D'Este and Patel, 2007; Ukwuoma et al., 2012; Yusuf, 2012). Bodies such as Committee of Vice Chancellors of Universities should help in ensuring constant interaction among universities.

6.3 Role of Researchers

Ultimately, researchers are the ones to ensure that they carry out the type of research that can lead to exploitable IPs. A number of things can be done by R&D personnel. There should be self-reform and paradigm shift towards research entrepreneurship. Researchers should improve their capacity for attracting funded research. They need to join and form research groups within and outside the university. They should establish linkages with foreign universities and industries. They should strengthen their capacity to disseminate their research results through publications, spin offs, conferences and workshops. Every researcher should work hard to increase web presence through uploading his/her work in university and personal websites and other web based platforms such as Research Gate, Academia.edu, Google Scholar, personal and university websites. Researchers should periodically do self-assessment and evaluation using indices such as H-Index and Impact Factor (Hirsch, 2005; 2007; Russel and Gathina, 1998; Saa-Perez et al., 2015; Okafor, 2011; Okpe et al., 2013). Researchers should break disciplinary walls and departmental boundaries and engage in multi-disciplinary research. By extension, they

should also look beyond their immediate environment for partnerships and support (Chiemeke et al., 2009; Onwualu, 2008; 2010; 2012).

6.4 Role of Industries

Some industries are already partnering with universities in the area of infrastructure development, support to students and researchers, research laboratories, equipment, scholarships, Professorial Chairs, etc. This needs to be increased. Industries should have a policy of challenging universities to solve their technical problems. They should be more receptive to researchers. Industries should make conscious effort at establishing linkages and collaborations with universities for mutual benefits and should also institute research funds to solve their technical problems.

7. CONCLUSIONS

We have seen that research that can generate exploitable IP, does not happen by chance. It must be designed, implemented and nurtured to a sustainable level. For a University, there must be a paradigm shift to become an Entrepreneurial University. There must be conscious efforts to form research groups and create Centres of Excellence around them. These groups should develop different world class proposals that will address major problems that are regional and global but also local. Such research should look at the big picture, address topical issues, build capacity, aim at IPs, multidisciplinary and use state of the art techniques. With the support of the University such groups can attract collaboration with other Universities, research institutes, industries and development partners. These will definitely lead to generation of exploitable IPs.

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