An informetric analysis of research output in Nigeria with special reference to universities: 2000-2010

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ABSTRACT

The need for sustainable evaluation of the research process and performance in Nigerian universities cannot be overemphasised. This research used bibliometric analysis, with publication output as a major indicator to evaluate research performance and productivity in Nigerian universities. The research results revealed that the first generation universities owned by the federal government were the five most productive universities in Nigeria. Biotechnology and Applied Microbiology was the most productive subject field, while research in Basic Sciences (Physics, Mathematics and Chemistry) was low, since these courses were not among the top 20 subject fields in Nigeria. Research results also revealed significant growth and progress in research and publications in Nigerian universities in the late 2000s. In terms of citation count and analysis, the University of Ibadan was ranked first, with 7.5 cites per article and a 38 h-index. It is recommended that more resources should be provided for research in the Basic Sciences to enhance effective scientific/technological development in Nigeria. It is further recommended that the National Universities Commission (NUC) should generate relevant parameters/indicators for national evaluation and ranking of Nigerian universities. Developing a national database of all the researchers, together with their publications, at Nigerian universities is highly recommended.

Key words

Basic Sciences, informetric analysis, Nigeria, research.

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1. INTRODUCTION

Universities are established so that academic staff (here referred to as "researchers") can impart knowledge for societal development through teaching and research. According to Gomez et al .(2007), universities play a significant role in the advancement of science in most countries by contributing "to the production of new knowledge, its transmission, its dissemination and its use in technical innovation". These researchers contend that university research is essential in developing the industrial, social and cultural values of a nation. The quality of research that is conducted at a given university, to a large extent determines the quality of expertise that is imparted to the larger society. Publication output is one of the critical indicators of the research productivity of researchers at universities. Thus, productivity is defined by most scholars in terms of publication output, by counting the number of papers that are produced by individual or groups of researchers, universities, countries/regions and disciplines over a period of time (Ani et al. 2003; Pienta 2004; Bottle et al. 1994).

Experts use publications count in the assessment and evaluation of the research performance of individual researchers, universities, countries/regions and disciplines. Bottle et al. (1994) conducted a comparative study of the productivity of senior academic chemists in the United Kingdom (UK) and the productivity of their counterparts at American universities between 1980 and 1991, using the Web of Science as their database. Their findings indicated no apparent "significant difference in productivity between the two countries, UK and USA". However, the same research indicated that British chemists published significantly more papers than their Nigerian counterparts over the same period. Pienta (2004) used two databases – the Web of Science and the ACS Directory of Graduate Research (DGR) (a database that "lists faculty and publications from all colleges and universities in the US and Canada that grant master's and doctoral degrees") – to indicate that differences exist among individual researchers in the field of Chemical Education in the United States (US). From data collected from the Web of Science (Dhawan and Gupta, 2007), it was found that of the 1307 institutions in India that participated in Physics research between 1993 and 2001, 64 "were rated as high productivity institutions (HPIs) with each publishing at least 100 papers during 1993-01".

A productivity analysis by Markusova et al. (2007), through using a combination of data sources, indicated Clinical Medicine as the most productive scientific discipline in the USSR/Russia and the US in 1988 and 2001. Thus, productivity measures have assisted scholars in staying abreast of trends in scientific/technological progress and development, and are used as a tool for the allocation of resources in research. Productivity measures can be used in policy formulation on a global, international, national and institutional level in tackling inefficiency in research among researchers and universities. It is used

by most governmental agencies/organisations for funding research to generate effective expertise in various disciplines.

Dore et al. (1996), in research on publication patterns of 48 countries between 1981 and 1992, using the Web of Science, found that the US was the most productive country in the world in terms of research. In Africa, South Africa was ahead of Egypt and Nigeria, while Clinical Medicine was the most productive discipline, with 18.6% of the total publication output**.** Recent researc by Pouris and Pouris (2007) confirmed South Africa (30.1%) and Egypt (20.2%) as the two leading countries in African research, followed by Morocco (7.9%) and Nigeria (5.9%). It has been observed that there is a paucity of literature on productivity measures and the evaluation of research performance in Nigeria. This research intends to bridge this gap.

Nigerian universities are classified as federal universities, state universities and (since recently) private universities (legislation to establish private universities was promulgated by the Federal Government of Nigeria in 1993). Federal universities are categorised into three basic groups:

- First generation universities: Five universities were established between 1948 and 1962.
- Second generation universities: Eight universities were established between 1970 and 1975.
- Third generation universities: These are universities established between 1980 and 1992 that are basically specialised universities (i.e. universities of Science and Technology and of Agriculture).

The federal and state universities in Nigeria are referred to as public universities. The establishment of state universities began in 1979, with Rivers State University of Science and Technology in Port Harcourt, while the first three private universities were founded in 1999. Currently, there are 36 federal universities, 36 state universities and 41 private universities in Nigeria (NUC 2011). The NUC is a regulatory agency for all Nigerian universities that sets general standards for academic programmes and courses in the universities and issues licenses for the establishment of new universities. The NUC has been on the forefront of working towards modalities for the evaluation of research performance at Nigerian universities, and the national ranking of the universities in view of their abysmal performance in the global and webometric ranking of world universities. Nigerian universities generally lag behind other universities in terms of the global ranking of universities. In Africa, only a few universities in Nigeria feature on the list of the top 100 universities (4International Colleges & Universities 2010). This paper provides a basis and modalities for the national ranking of universities in Nigeria, with the purpose of assisting to generate local parameters/indicators for the future ranking of

Nigerian universities that are in line with the global trend in "comparative analyses of performance of universities at national level" (Visser et al. 2007).

2. RESEARCH OBJECTIVES

The research objectives are similar to that of Gomez et al. (2007) and can be outlined as follows:

1. to identify the most productive universities in Nigeria and their publication output per year;
2. to identify main fields of research by Nigerian researchers;
3. to determine the trend in publication output in Nigerian universities between 2000 and 2010;
4. to determine the sources of publication of Nigerian researchers;
5. to assess the citation count and impact of the most productive universities in Nigeria; and
6. to determine the main language of publication of Nigerian researchers.

3. RESEARCH METHODOLOGY

Three databases on the Web of Science portal were used to obtain data for this research, namely: the Science Citation Index (SCI), the Social Science Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI). From several bibliometric indicators of research performance evaluation (such as publication output, citation analysis, impact factor and patent), only publication output and citations count and impact were used for this research. The choice of publication output and citation count and impact is due to the fact that these are the most common bibliometric indicators used in research output and impact assessments. As Pienta (2004) stated, publication output and citation impact are among the performance indicators generally considered to be objective and quantitative when measuring research output and impact. This observation has also been made by Lancaster (1991), the Committee on Science, Engineering, and Public Policy (COSEPUP) (2004), Garfield (1996) and Jacobs (2000). Except for the use of opinion polls, Brown (1993) identified three main approaches to evaluating scientific productivity besides the use of opinion polls, namely: peer review, the analysis of competition for funds, and citation analysis.

Given that there is no national bibliographic or citation database in Nigeria that can be used to evaluate research output in the country, the researchers opted to use a common source of data – the Web of Science – for this research. According to Abrahams et al. (2010), the Web of Science currently indexes articles across the world in over 10 000

journals in all fields of Science. It also indexes publications in the Social Sciences as well as in the Arts and Humanities. Abrahams et al. (2010) observed the following about the Web of Science: "as [an] original bibliometric database, it is regarded by most scholars as the benchmark for international visibility". The portal has since added two other databases, namely: Conference Proceedings Citation Index – Science (CPCI-S) (which indexes peer-reviewed conference proceedings from 2005) and Conference Proceedings Citation Index – Social Science & Humanities CPCI-SSH) (which covers coveringproceedings published since 2005). Thus, the choice of the Web of Science to conduct this research, will put Nigerian universities at the same level as other international universities for the evaluation of their research performance.

This research was limited to published journal articles since these are the basic means of communicating research findings. A search query (CU=Nigeria) was performed, using the Advanced Search platform to retrieve all articles containing the word "Nigeria" in the country of origin field. The search was limited to articles published between 2000 and 2010. An analysis of the records, using the Web of Science's built-in Analyse option, was conducted according to the *publication year*, in order to exclude records of articles that fell outside the 2000 to 2010 period, which was the theme of this research. It was observed that even if a searcher limited the period of research to specific years, the search would still retrieve records of articles published in years that did not form part of the analysis, hence the aforementioned analysis by year of publication. The Analyse option was used to identify the most productive universities, publication of research trends in Nigeria, the research focus of Nigerian researchers, and language of publication. Efforts to identify the most productive institutions in terms of research in Nigeria were limited to universities only. The results for university teaching hospitals were merged with their parent institutions, for example, articles indicating the name of the University College Ibadan were merged with those published by the University of Ibadan. Non-university institutions such as the Institute of Tropical Agriculture, Cocoa Research Institute of Nigeria and Federal Polytechnic (featuring among the top institutions) were excluded from the analysis. However, in analysing the most researched themes (language of publication, trend of publication and source of publication), no distinction was made, since the researchers were mainly concerned with the most common variables as opposed to the number of articles for each variable. It was noted, however, that the number of articles provided the most productive variables. The assumption was that similar variables would apply to research performance by universities in Nigeria and therefore provide a reasonably fair picture of the research themes, language of publication, trend of publication and source of publication. The Create Citation Report option on the results interface of the Web of Science portal was used to obtain citation counts, average citations per paper and the h-index for each top-ranked university in Nigeria – the purpose of which was to assess and compare the impact of research among the universities under investigation.

4. RESEARCH RESULTS

The research results are presented and discussed under the following subheadings: publication output by Nigerian universities per year; fields of research of Nigerian researchers; trends in publication output in Nigeria; sources of publication; citation count and analysis of top universities; and language of publication.

4.1 Publication output by Nigerian universities per year

Research results in table 1 indicate the productivity of the top 20 universities in Nigeria in terms of publication output as an indicator of research output. The table indicates that the University of Ibadan was the most productive, with a total of 2 310 articles, accounting for 17.1% of the total number of publications produced in Nigeria. In the second place was the Obafemi Awolowo University, publishing 1 352 [10.0%] articles, followed closely by the University of Nigeria (1 044, 7.7%), Ahmadu Bello University (854, 6.3%) and the University of Lagos (813, 6.0%). In terms of the average number of articles per year, the University of Ibadan produced 210 articles, followed by the Obafemi Awolowo University (122.9), the University of Nigeria (94.9), Ahmadu Bello University (77.6) and the University of Lagos (73.9).

Table 1: Top 20 universities in Nigeria and publication output

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Av/yr
Univ Ibadan	127	109	131	125	130	174	186	278	385	335	330	2310	210.0
Obafemi Awolowo Univ	75	59	77	80	87	116	139	166	214	198	141	1352	122.9
Univ Nigeria	61	57	61	54	61	70	66	90	161	171	192	1044	94.9
Ahmadu Bello Univ	64	58	60	74	62	57	54	84	127	100	114	854	77.6
Univ Lagos	40	23	38	35	49	56	66	109	149	132	116	813	73.9
Univ Benin	46	36	39	40	34	52	74	104	118	133	100	776	70.5
Univ Agr	32	37	29	32	42	54	50	78	109	71	90	624	56.7
Fed Univ Technol Akure	1	8	23	16	23	49	49	60	62	67	55	413	37.5
Univ Calabar	30	26	24	17	25	34	25	39	48	46	57	371	33.7
Univ Port Harcourt	15	10	13	17	22	35	41	49	42	56	43	343	31.2
Olabisi Onabanjo Univ	0	1	2	12	24	33	32	46	54	54	55	313	28.5
Univ Jos	40	24	22	12	22	24	29	25	39	36	36	309	28.1
Ladoke Akintola Univ Technol	13	7	11	19	16	26	21	45	46	52	45	301	27.4

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Av/yr
Lagos State Univ	4	8	8	13	14	22	22	34	42	69	55	291	26.5
Univ Maiduguri	29	22	26	15	15	13	20	23	29	43	37	272	24.7
Univ Uyo	11	10	15	11	11	15	20	22	38	61	53	267	24.3
Rivers State Univ Sci & Technol	14	11	24	18	19	19	28	43	28	23	18	245	22.3
Fed Univ Technol Owerri	2	6	14	10	17	24	25	38	35	20	28	219	19.9
Nnamdi Azikiwe Univ	25	12	17	10	8	10	11	14	30	30	29	196	17.8

A survey of the universities according to sponsoring agencies indicated that public universities (i.e. state and/or federally-owned universities) performed better than private universities. A similar pattern was observed by Gomez et al. (2007), who investigated the performance of public (federal and state) and private Spanish universities. They explained the public universities' better performance in research as follows that "public universities are older than private ones and show a larger size as measured through the number of students and professors". Similar factors might have influenced the pattern in Nigeria. From the results in table 1, it seems clear that the top 20 universities were public universities. This indicates that the productivity of Nigerian universities might be influenced by ownership, generation, the size/nature of the universities (i.e. conventional and/or specialised) and year of establishment. This might explain why no private universities that had been established more recently, and were thus smaller than the public universities, made it to the top 20 universities in Nigeria.

It was also observed that all five first generation universities were among the top universities in Nigeria. In fact, all five most productive universities in Nigeria were first generation universities. These universities are conventional in nature, with large student populations, a number of experienced researchers, and better funded and equipped than the other universities. For instance, the University of Ibadan (the oldest university in Nigeria) receives special funding from the federal government; it has the largest number of postgraduate students; attracts the highest number of external grants for research by seasoned researchers; and is involved in international collaborations. This could explain why the University of Ibadan was the most productive university in Nigeria from 2000 to 2010.

4.2 Fields of research of Nigerian researchers

The results of the evaluation of research and publication output in terms of fields of research as described by the Web of Science are presented in table 2 below.

Table 2: Publication output per research category in Nigeria, 2000–2010 (N=13493)

Subject category	No of articles	Percentage
Biotechnology & Applied Microbiology	1389	10.29
Food Science & Technology	1032	7.65
Public, Environmental & Occupational Health	909	6.74
Pharmacology & Pharmacy	758	5.62
Plant Sciences	711	5.27
Environmental Sciences	678	5.02
Tropical Medicine	670	4.97
Medicine, General & Internal	653	4.84
Agronomy	538	3.99
Agriculture, Multidisciplinary	511	3.79
Chemistry, Medicinal	501	3.71
Multidisciplinary Sciences	477	3.54
Chemistry, Applied	358	2.65
Veterinary Sciences	353	2.62
Obstetrics & Gynaecology	328	2.43
Engineering, Chemical	323	2.39
Pediatrics	284	2.10
Energy & Fuels	282	2.09
Nutrition & Dietetics	265	1.96
Parasitology	264	1.96

Biotechnology and Applied Microbiology is the most researched field of research in Nigeria and, by implication, at Nigerian universities. From the results, it seems obvious that scientific, medical, technological and agricultural fields dominate the top 20 fields of research in Nigeria. In fact, over 50% of the total number of articles published in Nigeria was in the six top-ranked field categories, which implies that these fields could be considered the core fields of research in Nigeria and at Nigerian universities. It is important to note that Nigeria is not excelling in terms of Basic Sciences (Physics, Mathematics and Chemistry). This leads to the belief that the pattern could be reversed if more attention was paid to effective and sustainable research in Basic Sciences, since these are pivotal for technological development and innovation of any nation.

Another factor that might have resulted in the Sciences performing better than the Social Sciences and Arts and Humanities is the coverage of Nigerian research in the citation databases that were used for this research. An analysis of Nigerian research (according to the citation index in which the articles are indexed) revealed that overall the Science Citation Index (SCI) yielded a total of 12 545 articles, while the Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI)

produced 1 411 and 166 articles respectively. As the analysis of articles by source of publication (i.e. journals) will reveal later, the majority of Nigerian journals covered in the three databases were Science-based; only two were Social Sciences-based, and none was Arts and Humanities-based.

4.3 Trends in publication output in Nigeria and Nigerian universities

Figure 1 indicates the trends in publication output in Nigeria by publication year from 2000 to 2010, while table 1 indicates the trends in publication output of the top 20 universities. The two illustrations are similar in pattern. In fact, a Pearson correlation test that was conducted (using the Microsoft Excel built-in formula "=Pearson(x, y)") among the universities' individual total production per year (x) against the aggregated number of publications in Nigeria per year (y), produced a Pearson product moment correlation coefficient of r=0.992 for the University of Ibadan. The r-values for the other top-ranked universities in table 1 were as follows: the Obafemi Awolowo University (r=0.944); the University of Nigeria (r=0.929); the Ahmadu Bello University (r=0.881); the University of Lagos (r=0.989); the University of Benin (r=0.980); the University of Agriculture (r=0.928); Federal University of Technology Akure (r=0.883); University of Calabar (r=0.901); University of Port Harcourt (r=0.891); Olabisi Onabanio University (r=0.929); University of Jos (r=0.628); Ladoke Akintola University of Technology (r=0.967); Lagos State University (r=0.943); University of Maiduguri (r=0.704); University of Uyo (r=0.911); Rivers State University of Science and Technology (r=0.480); Federal University of Technology Owerri (r=0.745); and Nnamdi Azikiwe University (r=0.738). Except for the Rivers State University of Science & Technology, which recorded a correlation coefficient below 0.5 (thereby indicating a weak relationship), all the universities had a correlation value of higher than 0.7. If each of the values was rounded to the nearest whole number, each of the universities would have recorded a correlation coefficient value of 1(one), which implies a perfect correlation between the individual university's total production per year and the aggregate number of publications in Nigeria per year.

In both cases, the results (i.e. individual and aggregated) reveal a significant increase in publication output in the late 2000s, although with a slight decrease in 2010. This indicates that there is a significant level of growth in research and publication output in Nigeria in general, and in Nigerian universities in particular. However, this needs to be improved upon if the country wishes to achieve higher rates of national development. The pattern of increased activity in research might be attributable to the relative improvement in government funding for education, training and research through improved budgetary allocation of funds to universities. It is believed that if this trend persisted, research output would continue to increase. There is a need for private sector intervention whereby multinational companies could sponsor research in universities in key fields of research that are pertinent for sustainable national development.

A close look at figure 1 below reveals that whereas the national research output has continued to increase, this growth has had mixed patterns in some periods (e.g. 2006 and 2008), with recorded drops in the number of articles, compared to the previous period. The line graph representing the change in the number of articles attests to this pattern. It can therefore be said that the growth of research output in Nigeria, and by implication in Nigerian universities, is linear in nature and not exponential.

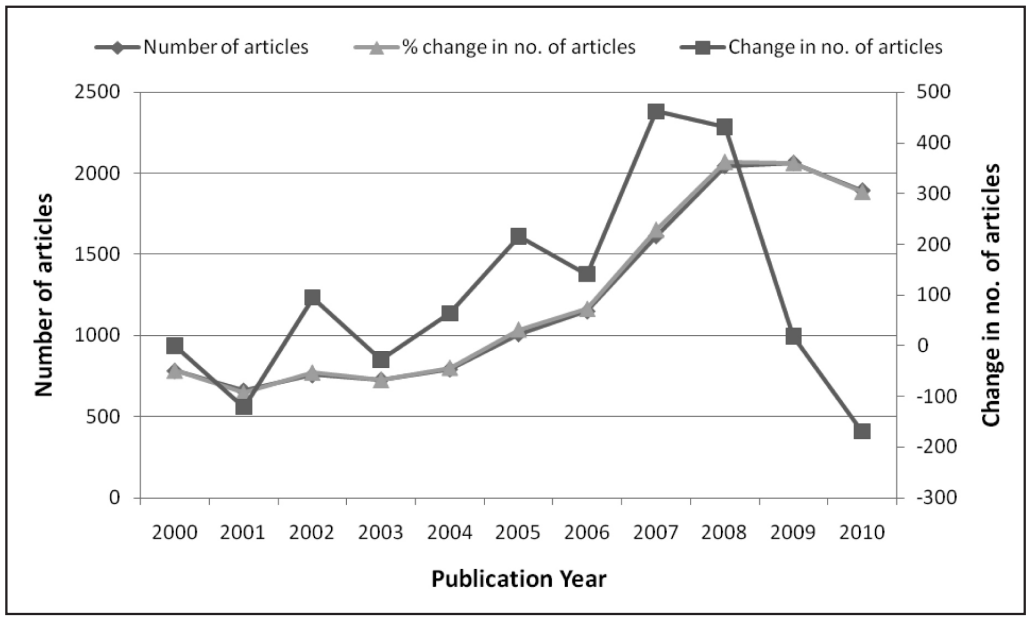

Figure 1: Trends in publication output in Nigeria, 2000–2010

4.4 Source of publication

Table 3 indicates the journals in which Nigerian researchers publish their research articles. The leading journal in terms of the number of articles was the *African Journal of Biotechnology*, which published a total of 1 123 articles (accounting for 8.32% of the total Nigerian publication output between 2000 and 2010). *Tropical Doctor* came a distant second with 201 (1.49%) articles, followed by the *Nigerian Journal of Clinical Practice* with 199 (1.47%), *Scientific Research and Essays* with 184 (1.36%) and the *African Journal of Agricultural Research* with 160 (1.19%). The top 20 journals (listed in table 3) published approximately 25% of Nigeria's total number of publications and can therefore be considered the key journals in which Nigerian researchers publish their research findings.

It was noted that the majority of the top 20 journals were based in foreign countries – not only outside Nigeria, but also not in Africa. Similar findings were reported by Onyancha and Ocholla (2008). It has been observed that researchers from developing

countries preferred to publish in foreign (international) journals, which are regarded as superior in quality to regionally published journals (Onyancha and Ocholla, 2004 and 2008). Notwithstanding this observation, five Nigerian journals feature among the top 20 journals listed in table 3. According to the available data, in the 2009 JCR (Journal Citation Reports®), the Institute of Scientific Information's (ISI) citation indexes cover only ten Nigerian journals, namely: *African Journal of Agricultural Research*; *African Journal of Microbiology Research*; *African Journal of Pharmacy and Pharmacology*; *African Journal of Traditional Complementary and Alternative Medicines*; *International Journal of Physical Science*s; *Journal of Medicinal Plants Research*; *Scientific Research and Essays*; *Tropical Journal of Pharmaceutical Research, African Journal of Business Management* and *African Journal of Library Archives and Information Science*. The last two journals are indexed in the Social Sciences field of research.

The ten journals indexed in ISI databases constitute a mere 3.1% of the academic/scholarly journals published in Nigeria. According to Ulrich Web's Global Serials Directory (accessed 14 March 2010), Nigeria publishes a total of 326 academic/scholarly journals. Of these journals, 194 are online journals; 184 constitute refereed journals; and 132 are covered in at least one abstracting and indexing service, while 23 are on open access. It goes without saying that the majority of the publications produced in Nigeria and published in Nigerian journals are not covered in ISI databases, a situation that underestimates the total research output emanating from Nigerian universities. Because of the ISI's biased coverage of African-based journals, some researchers have called for the development of an African citation index (see Nwagwu, 2005 and 2007).

Table 3: Sources for publishing Nigerian research (N=13493)

Journal	No of articles	Percentage
African Journal of Biotechnology	1123	8.32
Tropical Doctor	201	1.49
Nigerian Journal of Clinical Practice	199	1.47
Scientific Research And Essays	184	1.36
African Journal of Agricultural Research	160	1.19
Journal of Food Agriculture and Environment	158	1.17
Journal of Ethnopharmacology	136	1.01
Journal of the National Medical Association	126	0.93
African Journal of Microbiology Research	110	0.82
Journal of Medicinal Plants Research	107	0.79
International Journal of Physical Sciences	104	0.77
Journal of Home Economics Research	103	0.76
Discovery and Innovation	91	0.67
International Journal of Gynecology and Obstetrics	89	0.66

Journal	No of articles	Percentage
Journal of Animal and Veterinary Advances	88	0.65
Journal of Obstetrics and Gynaecology	87	0.64
Food Chemistry	80	0.59
Journal of Food Science and Technology-Mysore	79	0.59
African Journal of Pharmacy and Pharmacology	75	0.56
Asian Pacific Journal of Tropical Medicine	74	0.55

4.5 Citation count and analysis of top universities

An analysis of the citation count and its impact revealed mixed patterns, as some universities performed better than others in citation count, while performing poorer in terms of citations per paper and/or h-index. The most cited university was the Univ Ibadan which received 16744 citations followed by Obafemi Awolowo Univ (4046), Univ Nigeria (3383), Univ Lagos (2720), Univ Benin (2329) and Ahmadu Bello Univ (2252). In terms of cites per paper, the Univ Ibadan and the Fed Univ Technol Akure posted 7.25 cites per article, each followed by the Federal University of Technology Owerri (4.68), University of Calabar (4.55) and University of Jos (4.47). The highest h-index of 38 was scored by the University of Ibadan and the Federal University of Technology Akure. The Univ Nigeria recorded an h-index of 24, followed by Obafemi Awolowo University and the University of Lagos, with h-indices of 22 and 21 respectively.

Table 4: Citation count and analysis of Nigerian universities' publication output

	No of articles	No of cites	Cites per article	h-index
Univ Ibadan	2310	16744	7.25	38
Obafemi Awolowo Univ	1352	4046	2.99	22
Univ Nigeria	1044	3383	3.24	24
Ahmadu Bello Univ	854	2252	2.64	17
Univ Lagos	813	2720	3.35	21
Univ Benin	776	2329	3.00	21
Univ Agr	624	1599	2.56	15
Fed Univ Technol Akure	413	1160	7.25	38
Univ Calabar	371	1689	4.55	20
Univ Port Harcourt	343	1163	3.39	17
Olabisi Onabanjo Univ	313	1018	3.25	16
Univ Jos	309	1380	4.47	17
Ladoke Akintola Univ Technol	301	841	2.79	14
Lagos State Univ	291	646	2.22	12

	No of articles	No of cites	Cites per article	h-index
Univ Maiduguri	272	873	3.21	14
Univ Uyo	267	782	2.93	15
Rivers State Univ Sci & Technol	245	640	2.61	11
Fed Univ Technol Owerri	219	1025	4.68	18
Nnamdi Azikiwe Univ	196	500	2.55	10
Delta State Univ	195	273	1.40	8

When comparing the performance of Nigerian universities with their counterparts in countries such as South Africa, it was noted that most Nigerian universities' citation count and impact were low. The 2009 Essential Science Indicators (ESI), for instance, records that the University of Cape Town published a total of 9 639 articles, receiving a total of 106 960 citations (therefore a posting of 11.10 average citations per paper). The University of Pretoria recorded an average of 6.26 citations per paper from a total of 7 072 articles and 44 275 citations, while the University of Stellenbosch published 6 463 articles between 2000 and 2010 and received 59 472 citations (accounting for 9.20 citations per paper).

4.6 Language of publication

The predominant language of publication of Nigerian research articles was English, which yielded a total of 13 454 articles and accounted for 99.71% of the total Nigerian publication output. The second-placed language was French – with 29 (0.21%) articles, followed by Spanish (4, 0.03%), German (2, 0.01%), and Turkish (2, 0.01%). Portuguese and Romanian yielded one (0.01%) article each. In terms of the high level of English usage by Nigerian researchers, these findings are plausible, because English is the national language in Nigeria and the medium of teaching and instruction throughout the Nigerian education system (i.e. from universal basic education to higher education).

4.7 Most productive authors

Table 5 indicates the distribution of articles according to the most productive researchers and their affiliations. Topping the list is Gureje, from the University of Ibadan, with a total of 95 articles, accounting for 0.70% of the total number of publications produced in Nigeria between 2000 and 2010. In the second position was Sowunmi, from the same university as the aforementioned researcher, with 70 (0.52%) articles. Two researchers from the International Institute of Tropical Agriculture (IITA) were ranked third, fourth and fifth with 53 (0.39%), 49 (0.36%) and 48 (0.36%), respectively. Table 5 also reveals that the UNIV IBADAN appearedI on the list of the top 15 positions six times, implying that the majority of the most productive researchers were affiliated to the University. A

strong presence was also recorded by the IITA which appeared three times. The UNIV BENIN, UNIV CALABAR, OBAFEMI AWOLOWO UNIV, AHMADU BELLO UNIV and UNIV NIGERIA appeared once each. This pattern is in line with the findings of the most productive institutions where the UNIV IBADAN was ranked number one.

Table 5: Top 15 researchers and their institutional affiliations (N=13493)

Name	Institutional affiliation	Number of articles	%
GUREJE, O	UNIV IBADAN	95	0.70
SOWUNMI, A	UNIV IBADAN	70	0.52
DIXON, AGO	INT INST TROP AGR	53	0.39
ASIEDU, R	INT INST TROP AGR	49	0.36
OKIEIMEN, FE	UNIV BENIN	49	0.36
MENKIR, A	INT INST TROP AGR	48	0.36
OGUNWANDE, IA	UNIV IBADAN	48	0.36
EBENSO, EE	UNIV CALABAR	47	0.35
ADEWUYA, AO	OBAFEMI AWOLOWO UNIV	45	0.33
NOK, AJ	AHMADU BELLO UNIV	43	0.32
ONWUJEKWE, O	UNIV NIGERIA	43	0.32
ADEBOWALE, KO	UNIV IBADAN	42	0.31
FAROMBI, EO	UNIV IBADAN	42	0.31
GBOTOSHO, GO	UNIV IBADAN	42	0.31

5. CONCLUSION AND RECOMMENDATIONS

The need for sustainable evaluation of the research process and performance in Nigerian universities cannot be overemphasised. This research used bibliometric techniques and more particularly publication output and citation analysis to assess research performance at Nigerian universities. The research results revealed that first generation universities, owned by the Federal Government, were the most productive universities in Nigeria; Biotechnology and Applied Microbiology were the most productive fields of research in Nigeria; and research output in the Basic Sciences of Physics, Mathematics and Chemistry was low. The research also revealed significant growth and progress in research and publication in Nigerian universities in the late 2000s – a situation that correlated with the patterns witnessed in the analysis of the national research output. In terms of citation count and analysis, most universities in Nigeria registered low counts when compared to universities in other African countries such as South Africa. The University of Ibadan was ranked first, with 7.5 cites per article and an h-index of 38.

It was also noted that Nigerian researchers preferred publishing in foreign journals, as opposed to regionally published journals. Nevertheless, a few Nigerian universities featured among the top 20 journals in which Nigerian researchers published their research findings, implying that researchers also disseminate their research findings in local journals. In an analysis of the most productive researchers, it was noted that they (i.e. the researchers) were mostly affiliated to the most productive institutions.

The research recommends that more resources should be allocated to research in the Basic Sciences for effective scientific/technological development in Nigeria. It is also recommended that the NUC should generate relevant parameters/indicators for the national evaluation and ranking of Nigerian universities in view of the emergence of international rankings of universities, such as webometric rankings of world universities, where Nigerian universities significantly lag behind their international counterparts and even in Africa. In view of the Web of Science's limited coverage of local journals in Nigeria, it is recommended that the NUC should develop a national database to index Nigerian publications.

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