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A BIBLIOMETRIC STUDY ON THE WORLDWIDE RESEARCH PRODUCTIVITY OF SCIENTISTS IN *Elaeis guineensis* Jacq. AND *Elaeis oleifera*

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ABSTRACT

This article has the general aim of assessing the worldwide research productivity of Elaeis guineensis *Jacq. and* Elaeis oleifera *or more commonly known as oil palm, as reflected by the literature indexed in the Web of Science (WoS) and Scopus databases. Specifically, the research aims to identify the most productive countries, institutions and authors in this area of research. It also investigates the subject characteristics of the publication and collaborative patterns among researchers and institutions. Overall, based on the number of publications indexed by both WoS and Scopus, the Asian region, represented by seven countries, are the dominant producers of publications in this field, of which Malaysia is in the number one position. Whereas, USA and some European countries, such as United Kingdom and France, are also leading in terms of publications and citations. Research in the areas of food science and technology (WoS) as well as agricultural and biological sciences (Scopus) account for the highest number of publications. High levels of collaboration among authors are evident among the top 10 most productive countries. This is a good indication of collaboration impact with increased research output.*

Keywords: *Elaeis guineensis* Jacq., *Elaeis oleifera*, bibliometrics, oil palm, palm oil.

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INTRODUCTION

Palm oil which is produced from the fruits of the oil palm (*Elaeis guineensis* Jacq. and *Elaeis oleifera)* is the second largest edible oil worldwide, after soyabean oil. The *Elaeis guineensis* Jacq. originated from Africa, whilst the *Elaeis oleifera* originated from South America. In the past decade, palm oil was the highest produce of the world's production of oils and fats (Oil World, 2010), exceeding soyabean oil in terms of global production in 2005 (Cheng, 2010). Worldwide, palm oil production for season 2011/2012 was 50.3 million tonnes, increasing to 52.3 million tonnes for 2012/2013 (United States Department of Agriculture, 2012). It is thus by far the most widely-produced tropical oil, and constitutes almost 38% of total edible oil production worldwide (Basiron, 2011). From 1998 until late 2008, the international demand for palm oil had increased consistently, leading to alteration in the price of crude palm oil. Over 85% of the world's crude palm oil comes from Malaysia and Indonesia (Timms, 2007), providing a considerable income to the national and regional governments of these two countries. Since 1970s, Malaysia has strengthened its position as the primary producer and exporter of world palm oil. In line with the very rapid expansion of planted area, Indonesia overtook Malaysia as the world's biggest palm oil producer in 2007. The global production of palm oil has increased more than nine-fold in the past three decades, supplying the major markets including the European Union, China, Pakistan, India and Indonesia. Significant increases in production were also seen in countries

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such as Thailand, Ecuador, Colombia and Papua New Guinea, which collectively accounted for 6.6% of the world's production for 2009 (Wakker, 2000; Timms, 2007; Cheng, 2010).

A considerable amount of funding has been spent on research and development (R&D) initiatives such as oil palm genome mapping, so that palm oil will continue to play a positive role in the global supply and demand equation of the oils and fats industry. This relates to the importance of assessing the research activities in terms of productivity. Quantitative studies of publication patterns, also known as bibliometrics, are useful indicators of scientific productivity, trends, emphasis of research in various disciplines, and of researchers' preferences for publication output. The number of publications and the impact of scholarly productivity are accepted estimates of the quantity and quality of research performance. The Web of Science (WoS) and Scopus are two multidisciplinary citation databases that can be used to track the development of publications in a field of study using citation tracking. Although WoS is not a specialised database for the agricultural field, its multidisciplinary and international coverage help to broaden the analysis (Borsi and Schubert, 2011). Furthermore, whilst WoS is known to include only the top journals in a given field, Scopus is known for its wider coverage and greater international orientation (Bosman *et al*., 2006).

The literature on *Elaeis guineensis* Jacq. and *Elaeis oleifera* is quite scarce, though literature in the field of agriculture has evidently increased in recent years, including bibliometric studies on single fruits and on specific plants. Considering the commercial value of the oil palm, there is a need to study and understand the publication patterns in the scholarly published literature. Bibliometric analysis provides an opportunity to explore the output and capacity of worldwide research productivity of scientists studying *E. guineensis* Jacq. and *E. oleifera*. Furthermore, a comparison between WoS and Scopus is expected to assist in enhancing the system for tracking research productivity in the field of agriculture.

LITERATURE REVIEW

There have been various bibliometric studies in the field of agriculture, including studies on single fruits, trees or specific plants (Balog, 1985; 1984; Pouris, 1989; Nasir *et al*., 1994). Garg *et al*. (2006) analysed 16 891 documents published by Indian scientists during 1993-2002, which have been indexed by the Science Citation Index (WoS). They found that the publication output in the agricultural sciences has declined since 1998. Anwar-Mumtaz (2005; 2006) carried out an analysis of the literature on *Phoenix dactylifera* L. (date palm) and *Nigella sativa* (Habbat al-barakah or Black seed). He found that Iraq and Egypt were the most productive countries in this area of research. Some other researchers have studied the collaboration among individuals, institutions and countries in the field of agricultural science. In one of these studies, Gian *et al.* (2007) who studied the scientific output of researchers in *Embelia ribesthe*, a medicinal plant, found that Indian researchers contributed 63.9% of the publications in this area. Their study also showed that the contributing authors originated from 16 various countries, 91.3% of which were distributed across only five countries. More recently, Al-Qallaf (2009) reported that the literature in the field of *Punica granatum* L. (pomegranate) has grown consistently from 1970 onwards, where most of the publications are the result of author collaboration (71.82%). India and the United States were found to be the leading contributors to the literature. Analysing a total of 2603 research articles published by the scientists of the Central Potato Research Institute (CPRI) in India during 1991-2007, Sharma (2009) concludes that a majority of research publications were published in joint authorship. However, he did not find a uniform pattern of growth in publications during that examined years. Farahat (2002) also examined patterns of authorship in 19 Egyptian journals of agricultural science. He found that co-authored papers accounted for 79% of all examined papers.

Though WoS has been a well established citation index, used by many researchers undertaking bibliometric studies, the emergence of Scopus in 2004 and its wide coverage of publications has encouraged many researchers to compare the use of both these citation tracking databases. There has been a number of studies comparing WoS and Scopus in general (LaGuardia, 2005; Jasco, 2005; Meho and Yang, 2007; Gavel and Iselid, 2007) or on specific subject areas (Bakkalbasi *et al.,* 2006; Gorraiz and Schloegl, 2008; Lopes-Illescase *et al.,* 2009) with mixed results. In one of these studies, LaGuardia (2005) compared Scopus and WoS to facilitate the use of these databases by librarians. She concluded that Scopus is more suited for scientific, technical and engineering publications because of its larger coverage. Conversely, in the fields of arts, humanities, and/or social science, WoS had better performance. Bakkalbasi *et al*. (2006) compared WoS, Scopus and Google Scholar (GS) with a defined set of articles from two subject disciplines: oncology and condensed matter physics. They found that Scopus showed strength in providing citing literature for current oncology articles, while the WoS produced more citing material condensed matter physics. This led them to conclude that the question of which tool provides the most complete set of citing literature

may depend on the subject and publication year of a given article. In another study, Gorraiz and Schloegl (2008) examined the suitability of Scopus and WoS for bibliometric analysis in the subject of pharmacy and pharmaceutical sciences. They found that pharmacy journals with high impact factors usually have high impact factors in Scopus as well. Furthermore, several medium impact journals identified in Scopus were not reported in the *Journal Citation Report* of WoS. Torres-Salinas *et al*. (2009) compared the differences in the number of citations compiled with Scopus as opposed to the WoS, with the aim of analysing the agreement among the citation rankings generated by these databases. The results indicate that the publications reflected in the WoS during the period 1999-2005 received 14.7% more citations in Scopus. In the case of the ranking of citations, it was found that both databases generally produce similar results. Archambault *et al*. (2009) compared the documents produced from the WoS and Scopus databases for the 1996-2007 period. Their analysis provided evidence that indicators of scientific production and citations at the country level are stable and largely independent of the database used. Finally Vieira and Gomes (2009) presented a detailed paper of the coverage achieved by WoS and Scopus for the output of a typical university. It was found that about two-third of the documents indexed in any of the two databases may be found in another one. However, they cautioned that some high impact documents, which may be found among some of the other documents were found in only one database. However, a review of the existing literature a shows that the productivity and collaboration of researchers, institutions and countries in the area of oil palm research have not been investigated so far. As a result, the current study aims to study the worldwide research productivity of scientists in *E. guineensis* Jacq. and *E. oleifera*.

RESEARCH OBJECTIVES

The general aim of this study is to analyse the worldwide scientific productivity of publications in oil palm research, as reflected in its publication output during 1995-2010. The study specifically focused on the following objectives:

- to study the overall publication productivity of the oil palm research by countries, institutions and authors in the field;
- to identify the subject dispersion in the publication of the oil palm research;
- to study the scientific collaboration patterns of researchers over the studied period; and
- to identify the most productive journals in the field.

Results from this study contribute to a better understanding of the oil palm research field that has been confined to a small number of countries only. However, the objective is not to provide an assessment of countries but rather to compare the results obtained from the two sources, in order to evaluate the robustness of the two bibliometric databases, as well as of bibliometrics as a scientific undertaking. These results will also serve in related studies as a baseline for the evaluation and testing of bibliometric methodologies; especially as they are applied to highly collaborative research fields.

RESEARCH METHODOLOGY

This study adopted a bibliometrics methodology to examine publication productivity in oil palm research. The investigation was based on databases of Thomson Reuters' WoS and Elsevier's Scopus. This study considered all documents published between 1995 and 2010 in journals indexed by these two databases. WoS indexes more than 10 000 journals (http://thomsonreuters.com) compared to Scopus 18 000 journals (http://www.info.sciverse.com). Data from WoS were collected from Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI). Data from Conference Proceedings Citation Index-Science (CPCI-S) and Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH) were excluded. The query for search in WoS was performed as follows: TS = ("palm oil") or TS = ("oil palm") or TS = ("*Elaeis guineensis* Jacq.") or TS = ("*Elaeis oleifera*"). A total of 4110 records were retrieved from the WoS. A total of 4824 records were also found in Scopus using the following search string: TITLE-ABS-KEY ("palm oil" or "oil palm" or "*Elaeis guineensis* Jacq." or "*Elaeis oleifera*") and PUBYEAR AFT 1994 and PUBYEAR BEF 2011. Clean, accurate and complete data is crucial to any form of bibliometric analysis. All documents were reviewed in order to identify their geographical origin and to determine the number of publications and citations per year, the most productive countries, institutions and authors, language of publications, document types, source of publications, subject area of publications and research productivity and collaboration practices. The records were then analysed using a Microsoft Excel spreadsheet application.

Geographical Assignment

For the purposes of the present study, the world was divided into nine regions based on a combination of geographic, economic and scientific criteria: Western Europe, USA, Japan, Canada, Asia,

Eastern Europe, Oceania, Latin America and the Caribbean and Africa. All former socialist countries of Europe and Turkey were included in the category of Eastern Europe. Greenland was designated to be part of Western Europe. Japan was studied as a separate region relative to the rest of Asia. Puerto Rico and the Virgin Islands were included within the USA region. Accordingly, 83 countries were identified in the data collection.

Document Type and Subject Type

Both document type and subject type of each publication was based on the assigned values by each citation database. Scopus assigns 15 document types: article, abstract report, article in press, book, business article, conference paper, conference review, editorial, erratum, letter, note, press release, report, review and short survey, whereas 12 types were identified in WoS. As for subject categories, WoS has 36 categories for document type. Many of which are similar to those in Scopus, but with additional categories for art and music related themes.

AUTHOR'S NAME DISAMBIGUATE

Some problems were encountered during counting, spelling variations of the same names, same author with different names and same names for multiple authors. The first step was the compatibility of author names requires equal normalised last names, and compatibility of full first names and/or initials. Variations in Malay names especially posed a problem because there is no distinct first name and last name.

RESULTS AND DISCUSSION

The overall publication activity was analysed based on productivity by geographical region, publication and citation trend, document types, most productive institutions and language used in publications.

Productivity by Geographical Region

Table 1 shows the distribution of manuscripts published by countries as listed in WoS (83 countries) and Scopus (93 countries) for the period of 1995-2010. Overall, the publication of the countries vary from 0.2% - 31.16% (WoS) and 0.14% - 29.61% (Scopus) during 1995-2010. The Asian region is highly responsible for the world scientific production in this field, as reflected by 54.12% publications indexed in WoS and 51.18% in Scopus. Among the top 20 countries, Asia contributed 53.60% of the total publication in WoS and 46.60% in Scopus, of which almost more than half of the publications were from Malaysia. Malaysia, the second main producer and

TABLE 1. TOP 20 COUNTRIES IN NUMBER OF PUBLICATIONS AS LISTED BY THE WEB OF SCIENCE (WoS) AND SCOPUS (1995-2010)

WoS (4110)				Scopus (4824)			
Rank	Country	Publication	% of Publication	Rank	Country	Publication	% of Publications
1	Malaysia	1 281	31.168	1	Malaysia	1 489	29.608
2	USA	393	9.562	2	USA	368	7.318
3	Japan	279	6.788	3	UK	327	6.502
4	France	223	5.426	4	Japan	309	6.144
5	England	215	5.231	5	Nigeria	260	5.170
6	Nigeria	165	4.015	6	France	240	4.772
7	India	190	4.623	7	India	202	4.017
8	Thailand	154	3.747	8	Thailand	180	3.579
9	Brazil	150	3.650	9	Brazil	135	2.684
10	Canada	140	3.406	10	Canada	133	2.645
11	Spain	125	3.041	11	Indonesia	130	2.585
12	China	119	2.895	12	Spain	128	2.545
13	Germany	113	2.749	13	Germany	116	2.307
14	Indonesia	105	2.555	14	China	110	2.187
15	Australia	98	2.384	15	Australia	101	2.008
16	Italy	80	1.946	16	Netherlands	79	1.571
17	Turkey	79	1.922	17	Colombia	74	1.471
18	Netherlands	76	1.849	17	Singapore	74	1.471
19	Singapore	75	1.825	19	Italy	61	1.213
20	Colombia	60	1.460	20	Belgium	47	0.935

exporter of world palm oil, led in term of research productivity in this field. Approximately of 31.17% and 29.61% of articles indexed in both WoS and Scopus respectively were affiliated to Malaysia. USA ranked second in both WoS and Scopus (9.56% WoS; 7.32% Scopus), however Japan ranked third in WoS (6.78%) but was fourth in Scopus (6.14%). In Scopus, United Kingdom ranked third (6.50%). The other countries in the top 10 spots (France, United Kingdom, Nigeria, India, Thailand, Brazil and Canada) shared 30.09% (WoS) and 29.01% (Scopus) of the publication. Spain ranked 11 in WoS, and 12 in Scopus, after Indonesia.

The rest of the publications were from more than 56 other countries that range of a total of 19 to at least two papers each. An interesting finding is that though Indonesia is currently the highest producer of palm oil, it ranked 14 in WoS and 11 in Scopus in terms of publication productivity, contributing only 2.56% and 2.58% of the publication in WoS and Scopus respectively. Among the other Asian countries, Bangladesh, Hong Kong, Cambodia and Saudi Arabia have no publication share in WoS. These palm oil non-producer countries however contributed less than 1% in Scopus. Turkey was at number 17 in WoS but fell to number 26 in Scopus, whereas Greece, Mexico and Portugal did not appear in Scopus's top countries with at least 20 publications. The top 20 countries listed in Scopus also appeared in the top 20 in WoS except for Belgium, South Africa, Switzeland, South Korea and Sweden (19-23 respectively in Scopus). It can be concluded that prolific countries in research and publication in oil palm are well represented in both WoS and Scopus. *Figure 1* represents the percentage of articles in both WoS and Scopus for the top 20 countries. Malaysia clearly supersedes the other top 20 countries. In fact the Asian countries contributed to almost 54% of publications by the top 20 countries in the world, as shown in *Figure 2*.

It is evident from *Figure 2a* that Asia is the dominant producer of publications compared to the other continents. The top Asian country is Malaysia (*Figure 2b*), comprising 31% of the total publications, of the top Asian countires in WoS.

Productivity by Year of Publication

Table 2 shows the distribution of publications and citations per year, citations per paper and h-index in both WoS and Scopus. Generally, there is an increasing trend in the number of publications and citations per year in both WoS (*Figure 3*) and Scopus (*Figure 4*), with some fluctuations between years. The overall R^2 value for publications of 0.68 (WoS) and 0.76 (Scopus) indicate a steady and significant increase over the years, as shown in *Figures 3* and *4* respectively.

There was a significant increase in the number of publications in Scopus between the years 2006 to 2010. In WoS, however, the increase was gradual. The citations in papers published between 1995-2000 gives rise to the h-index of these years. In Scopus, the highest h-index, 31 (*Table 2*) occurred in year 2002. The lower h-index from year 2001-2010 was expected, as the more recent articles may not have been cited as many times.

Productivity by Document Types

The top category of document types published by both Wos and Scopus were journal articles, comprising 81.74% of the documents in WoS and 82.76% of the documents in Scopus followed by

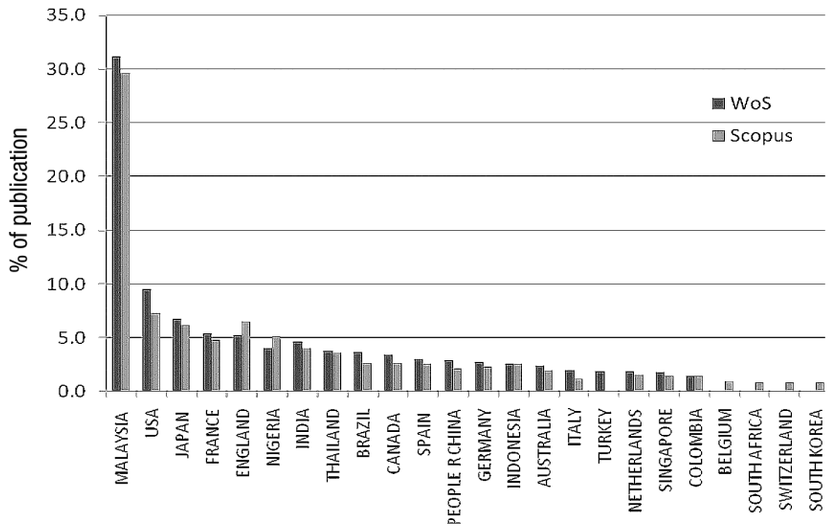


Figure 1. Percentage of publications by top 20 countries in the Web of Science (WoS) and Scopus.

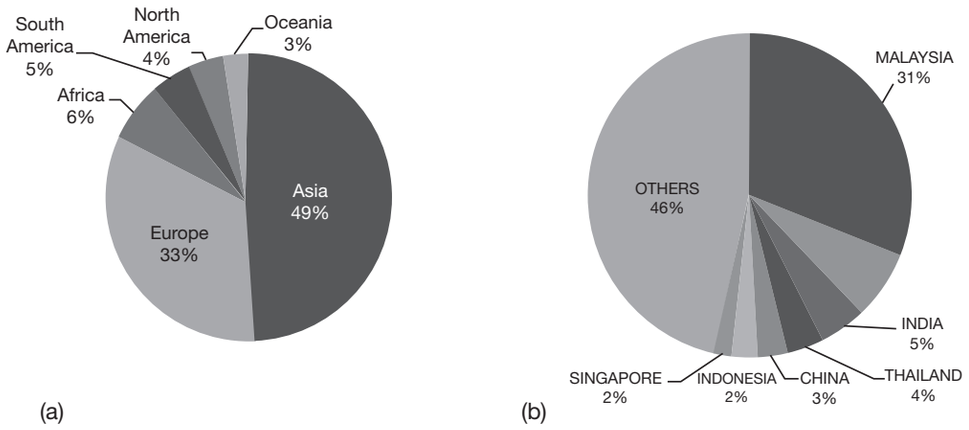


Figure 2. Share of publications in (a) different continents and (b) different Asian countries.

TABLE 2. PUBLICATION AND CITATION COUNT BY YEAR – WEB OF SCIENCE (WoS) AND SCOPUS (1995-2010)

Publication year	Publication		Citations		Citations per paper		h-index	
	WoS	Scopus	WoS	Scopus	WoS	Scopus	WoS	Scopus
2010	705	793	1 779	1 937	2.52	2.44	15	16
2009	506	595	3 082	2 751	6.09	4.52	24	24
2008	423	496	3 509	2 699	8.29	5.44	29	27
2007	339	462	3 291	3 529	9.70	7.63	28	28
2006	238	337	2 829	3 144	11.88	9.32	29	28
2005	255	294	3 229	2 892	12.66	9.83	28	27
2004	204	232	3 025	3 094	14.82	13.33	29	28
2003	171	201	2 565	2 723	15.00	13.54	33	29
2002	180	204	2 879	3 269	15.99	16.02	27	31
2001	185	210	2 275	2 614	12.29	12.44	30	29
2000	193	226	3 785	2 552	19.61	11.29	28	27
1999	158	172	2 491	2 989	15.76	17.37	26	28
1998	140	153	2 892	2 989	20.65	19.53	27	28
1997	136	169	2 444	2 870	17.97	16.98	30	30
1996	135	167	1 697	2 539	12.57	15.20	27	26
1995	156	113	1 997	3 736	12.80	33.06	26	25

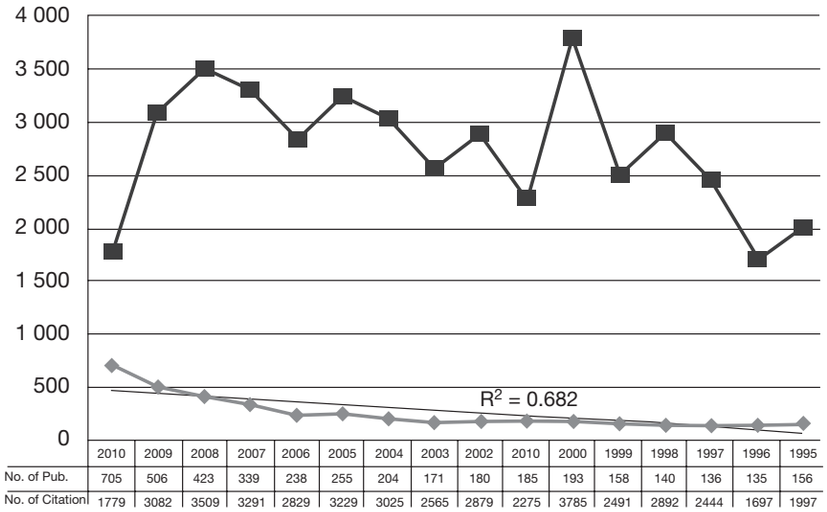
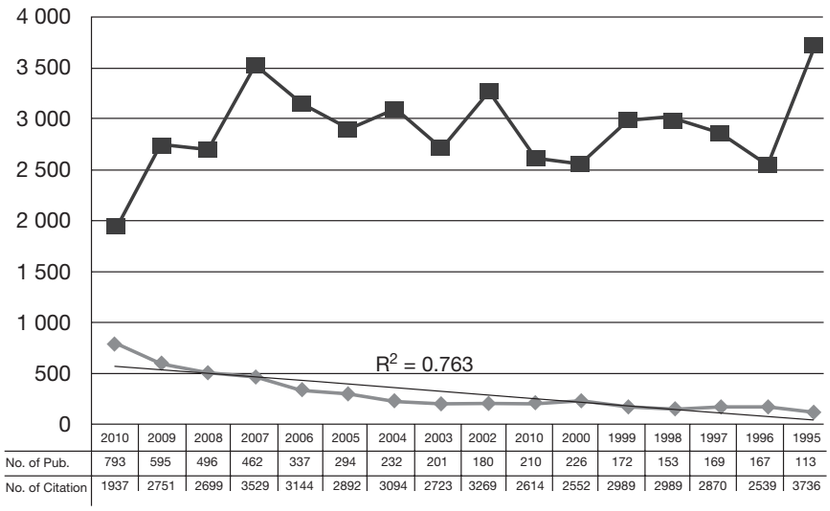


Figure 3. Publication and citation trends in the Web of Science (WoS).



	2010	2009	2008	2007	2006	2005	2004	2003	2002	2010	2000	1999	1998	1997	1996	1995
No. of Pub.	793	595	496	462	337	294	232	201	180	210	226	172	153	169	167	113
No. of Citation	1937	2751	2699	3529	3144	2892	3094	2723	3269	2614	2552	2989	2989	2870	2539	3736

Figure 4. Publication and citation trends in Scopus.

TABLE 3. WEB OF SCIENCE (WoS) AND SCOPUS PUBLICATION COUNT BY DOCUMENT TYPES (1995-2000)

Document type	WoS		Scopus	
	No. of publications	% of publications	No. of publications	% of publications
Article	3 606	87.74	3 988	82.756
Proceedings paper	379	9.22	385	7.989
Review	175	4.26	202	4.192
Meeting abstract	81	1.971	-	-
Note	6	0.146	102	2.117
Business article	-	-	43	0.892
Editorial material	22	0.535	14	0.291
News item	26	0.633	-	-
Letter	21	0.511	35	0.726
Book chapter	10	0.243	-	-
Book review	6	0.146	-	-
Correction	8	0.19	-	-
Correction, addition	-	-	4	0.083
Article in press	-	-	9	0.187
Report	-	-	1	0.021
Short survey	-	-	23	0.477
Conference review	-	-	13	0.270
Undefined	-	-	5	0.104

proceedings and reviews. In the WoS, the remaining document types included in publications were abstracts, notes, editorial materials, news items, letters, book reviews and book chapters. Scopus, however, does not cover abstracts, news items, book reviews and book chapters (*Table 3*). Scopus does however include articles in press, short surveys and conference reviews. A small number of publication types in Scopus (0.10%) could not be defined. The high percentage of journal articles in the oil palm literature is consistent with the findings of other fields of research in agriculture.

Productivity of the Institutions

The institutions contributing 20 or more articles in the 1995-2010 were included in the list of major institutions. *Table 4* presents the most productive institutions that contribute to the world scholarly publications on *E. guineensis* Jacq. and *E. oleifera*, indexed by WoS and Scopus. The top six productive institutions are from Malaysia, contributing a total publication of 31.95% in WoS and 30.742% in Scopus. Among these six institutions, five are universities, whilst the top research institutions is the

Malaysian Palm Oil Board (MPOB). Universiti Sains Malaysia and Universiti Putra Malaysia (a research university with a research focus on agricultural sciences) are the top two in both databases, whereas University of Malaya ranks fourth in WoS (3rd in Scopus) and Universiti Kebangsaan Malaysia ranks fifth in WoS (3rd in Scopus). As these four universities are research-based universities, it explains the strength of research and publications in palm oil and oil palm in Malaysia.

CIRAD (*Centre de coopération internationale en recherche agronomique pour le développement*), a French research centre, which is based in a non-oil palm producing country, is productive in both WoS and Scopus. It works with developing countries to tackle international agricultural and developmental issues (http://www.cirad.fr/en). CIRAD ranks seventh in productivity with a larger number of publications in WoS (1.241%) and is sixth in Scopus (1.845%). Overall, the findings indicate that WoS and Scopus did not show significant difference in the ranking of the top 10 institutions in terms of publication productivity, of which six were from Malaysia (Universiti Putra Malaysia, Universiti Sains Malaysia, University of Malaya, MPOB, Universiti Kebangsaan Malaysia and Universiti Teknologi Malaysia) and the other four were from France (CIRAD), Singapore (Nanyang Technological University), Thailand (Prince Songkla University) and Brazil (Universidade Estadual de Campinas). However, the next top 10 of the top 20 institutions varied between WoS and Scopus. Surprisingly two of the top 20 productive institutions listed in WoS; the Spanish National Research Council and the French National Institute of Agricultural Research did not have any publications listed in Scopus (*Table 4*).

Subject Area of the Publications

Identification of subject categories for both WoS and Scopus was based on subjects provided by each database. Both returned a total of 90 and 27 subject areas, respectively. In WoS, the top listed publications appeared under the subject food science and technology (22.55%) and applied chemistry (17.14%), whereas in Scopus the top subject for oil palm publications was agricultural and biological sciences (40.31%) followed by chemistry (17.09%), chemical engineering (16.51%), biochemistry, genetics and molecular biology (16.14%) and medicine (14.02%). Since several subjects may have been assigned to the same

TABLE 4. MOST PRODUCTIVE INSTITUTIONS IN THE WEB OF SCIENCE (WoS) AND SCOPUS

	Institution	Country	WoS		Scopus	
			Publication (rank)	% of Publications	Publication (rank)	% of Publications
1	Universiti Sains Malaysia	Malaysia	350(1)	8.516	365 (2)	7.566
2	Universiti Putra Malaysia	Malaysia	345(2)	8.394	465(1)	9.639
3	Malaysian Palm Oil Board	Malaysia	266(3)	6.472	288 (3)	5.970
4	University of Malaya	Malaysia	139(4)	3.382	164 (5)	3.400
5	Universiti Kebangsaan Malaysia	Malaysia	125(5)	3.041	185 (4)	3.835
6	Universiti Teknologi Malaysia	Malaysia	53(6)	1.290	76(7)	1.575
7	CIRAD	France	51(7)	1.241	89(6)	1.845
8	Nanyang Technol University	Singapore	44(8)	1.071	48(9)	0.995
9	Prince Songkla University	Thailand	44(8)	1.071	57(8)	1.182
10	Univ Estadual Campinas	Brazil	44(8)	1.071	32(13)	0.663
11	University of Guelph	Canada	30(11)	0.730	24(18)	0.498
12	Universiti Malaysia Sabah	Malaysia	30(11)	0.730	48(9)	0.995
13	Chulalongkorn University	Thailand	28(13)	0.681	28(16)	0.580
14	Mahatma Gandhi University	India	28(13)	0.681	32(13)	0.663
15	Spanish National Research Council	Spain	27(15)	0.657	-	-
16	Kyushu Inst Technol	Japan	27(15)	0.657	37(12)	0.767
17	Universiti Teknol MARA	Malaysia	26(17)	0.633	47(11)	0.974
18	French National Institute of Agricultural Research	France	24(18)	0.584	-	-
19	Kyoto University	Japan	24(18)	0.584	24(18)	0.498
20	University of Georgia	USA	24(18)	0.584	24(18)	0.498
21	University of Stirling	UK	23(21)	0.560	-	-
22	Obafemi Awolowo Univ	Nigeria	-	-	32(13)	0.663
23	Univ Ibadan	Nigeria	-	-	28(16)	0.580
24	King Mongkut University of Tech	Thailand	-	-	28(16)	0.580

publication, the analysis did not add to 100%, it only gave a general overview of the subjects assigned (*Table 5*). It is noticeable here that Scopus has a wider subject themes ranging from sciences, social sciences, psychology, humanities and economics. WoS on the other hand, assigns subjects strictly adhering to the sciences. The 985 articles in WoS are in the remaining 60 categories of subject headings.

Productivity of the Researchers

A total of 4436 authors contributed to the 4110 papers indexed in WoS, of which 232 authors produced seven or more papers each. In Scopus, 158 authors produced at least seven papers during the studied period. *Table 6* presents the top 20 prolific authors by rank in both WoS and Scopus. The

TABLE 5. SUBJECT AREAS OF THE PUBLICATIONS THE WEB OF SCIENCE (WoS) AND SCOPUS

WoS				Scopus			
Rank	Subject area	No. of publication	% of publications	Rank	Subject area	No. of publications	% of publications
1	Food science & technology	925	22.55	1	Agricultural & biological sciences	1 945	40.32
2	Chemistry, applied	703	17.14	2	Chemistry	863	17.89
3	Agronomy	483	11.77	3	Chemical engineering	795	16.48
4	Nutrition & dietetics	480	11.70	4	Biochemistry, genetics & molecular biology	777	16.11
5	Engineering, chemical	464	11.31	5	Medicine	676	14.01
6	Biotechnology & applied microbiology	376	9.17	6	Environmental science	538	11.15
7	Energy & fuels	372	9.07	7	Engineering	511	10.59
8	Biochemistry & molecular biology	279	6.80	8	Energy	403	8.35
9	Plant sciences	247	6.02	8	Materials science	403	8.35
10	Environmental sciences	210	5.12	10	Immunology & microbiology	217	4.50
11	Agriculture, multidisciplinary	174	4.24	11	Multidisciplinary	184	3.81
12	Agriculture, dairy & animal science	163	3.97	12	Social sciences	157	3.25
13	Polymer science	163	3.97	13	Pharmacology, toxicology & pharmaceutics	130	2.69
14	Chemistry, physical	139	3.39	14	Physics & astronomy	126	2.61
15	Agricultural engineering	135	3.29	15	Nursing	118	2.45
16	Engineering, environmental	129	3.14	16	Earth and planetary sciences	113	2.34
17	Materials science, multidisciplinary	108	2.63	17	Veterinary	90	1.87
18	Chemistry, multidisciplinary	103	2.51	18	Business, management & accounting	57	1.18
19	Ecology	88	2.15	19	Computer science	55	1.14
20	Multidisciplinary sciences	67	1.63	20	Economics, econometrics & finance	33	0.68
21	Chemistry, analytical	62	1.51	21	Mathematics	22	0.46
22	Cell biology	57	1.39	22	Undefined	15	0.31
23	Fisheries	56	1.37	23	Arts & humanities	8	0.17
24	Engineering, mechanical	53	1.29	24	Neuroscience	7	0.15
25	Horticulture	51	1.24	25	Psychology	4	0.08
26	Water resources	51	1.24	26	Health professions	4	0.08
27	Soil science	48	1.17	27	Decision sciences	3	0.06
28	Entomology	45	1.10	28	Entomology	-	-
29	Veterinary sciences	42	1.02	29	Veterinary sciences	-	-
30	Biology	37	0.90	30	Biology	-	-

TABLE 6. PROLIFIC AUTHORS LISTED IN THE WEB OF SCIENCE (WoS) AND SCOPUS

No.	WoS					Scopus				
	Author	Rank	Record Count	% of 4110	Country	Author	Rank	Record Count	% of 4824	Country
1	Man, Y B C	1	59	1.436	Malaysia	Man, Y B C	1	63	1.306	Malaysia
2	Bhatia, S	2	57	1.387	Malaysia	Bhatia, S	2	55	1.140	Malaysia
3	Mohamed, A R	3	39	0.949	Malaysia	Hassan, M A	3	47	0.974	Malaysia
4	Ahmad, A L	4	38	0.925	Malaysia	Ismail, H	4	42	0.871	Malaysia
5	Thomas, S	5	37	0.900	India	Ahmad, A L	5	41	0.850	Malaysia
6	Hassan, M A	6	36	0.876	Malaysia	Mohamed, A R	6	38	0.788	Malaysia
7	Lee, K T	7	36	0.876	Malaysia	Shirai, Y	7	36	0.746	Japan
8	Ismail, H	8	32	0.779	Malaysia	Rozman, H D	8	34	0.705	Malaysia
9	Lua, A C	9	31	0.754	Singapore	Lee, K T	9	29	0.601	Malaysia
10	Khalil, H P S A	10	29	0.706	Malaysia	Abdul Khalil, H P S	10	28	0.580	Malaysia
11	Rozman, H D	10	29	0.706	Malaysia	Lua, A C	11	27	0.560	Singapore
12	Guo, J	12	28	0.681	China	Hameed, B H	11	27	0.560	Malaysia
13	Hameed, B H	13	27	0.657	Malaysia	Ghazali, H M	13	24	0.498	Malaysia
14	Shirai, Y	13	27	0.657	Japan	Thomas, S	13	24	0.498	India
15	Nesaretnam, K	15	23	0.560	Malaysia	Guo, J	15	22	0.456	China
16	Yunus, W M Z W	15	23	0.560	Malaysia	Choo, Y M	15	22	0.456	Malaysia
17	Duval, Y	17	22	0.535	France	Masjuki, H H	17	21	0.435	Malaysia
18	Choo, Y M	18	20	0.487	Malaysia	Abd-Aziz, S	17	21	0.435	Malaysia
19	Chuah, C H	18	20	0.487	Malaysia	Duval, Y	19	20	0.415	France
20	Ng, W K	18	20	0.487	Malaysia	Rival, A	20	19	0.394	France

most prolific authors were Man, Y B C (Universiti Putra Malaysia) and Bhatia, S (Universiti Sains Malaysia), who contributed more than 1% in WoS and Scopus. The top 10 authors listed in WoS also appeared in Scopus, except for Thomas, S from India (fifth in WoS but 13th in Scopus) and Lua, A C from Singapore (ninth in WoS and 11th in Scopus). The origin of authors revealed that 75% of the top 20 authors in WoS and 70% in Scopus were Malaysian authors. The other countries with productive authors were India, China, Japan, Singapore and France.

Scientific Collaboration of Countries with Malaysia

Scientific collaboration between Malaysia, the most productive country in *E. guineensis* Jacq. and *E. oleifera*, and other countries was examined. *Table 7* shows the results from WoS and Scopus. Several countries have strong collaborative ties with Malaysian authors. Malaysia's palm oil and oil palm researchers have collaborated with researchers from 24 different countries, resulting in at least two papers based on normal count. The highest number of collaboration was with Japan (81). The United States, United Kingdom (England, Scotland, Wales), Indonesia and Canada also had the highest number of collaborative papers with Malaysia. Though France is also a highly productive country, its collaboration with Malaysia is not very encouraging, only five documents in WoS and eight in Scopus (*Table 7*).

Identification of Core Journals

The literature on *E. guineensis* Jacq. and *E. oleifera* covered in the present study (1995-2010) comprises a total of 4110 articles indexed by WoS and 4824 indexed by Scopus. *Table 8* illustrates the distribution of the articles in the top productive journals with JCR 2010 impact factor and Scopus Journal ranking SJR 2010, a measure of quality. The largest number of papers were published in *Journal of the American Oil Chemists Society* (168), followed by *Journal of Oil Palm Research* (80), *Bioresource Technology* (73) and *European Journal of Lipid Science and Technology* (69). Analysis shows that not all WoS-covered palm oil and oil palm journals (n= 561) are indexed in Scopus, but that Scopus covers many more journals (n=728, an additional n =167). Therefore in terms of palm oil and oil palm journals coverage, WoS constitutes a genuine subset of Scopus. Though *Bioresource Technology* is ranked third in WoS, it has the highest impact factor (4.365) among the top 10 journals. Two of the top 10 journals in WoS are not indexed by Scopus, the Malaysian *Journal of Oil Palm Research* ranked second with 80 articles and *Energy Fuels* which is ranked eighth. Of the top 10 journals indexed in Scopus, four do not appear in WoS's top 10. *Journal of Applied Sciences* ranks fifth in Scopus is not indexed by WoS.

TABLE 7. COLLABORATION BETWEEN MALAYSIA AND OTHER COUNTRIES

	Country	Web of Science		Scopus	
		No. of collaboration	% of Malaysian productivity	No. of collaboration	% of Malaysian productivity
1	Japan	81	5.77	71	6.42
2	USA	58	4.13	29	2.62
3	England	39	2.78	34	3.07
4	Canada	30	2.14	11	0.99
5	Indonesia	24	1.71	16	1.44
6	Australia	19	1.35	7	0.63
7	Singapore	12	0.85	7	0.63
8	Germany	11	0.78	8	0.72
9	Netherlands	11	0.78	7	0.63
10	Scotland	10	0.71	-	-
11	Iran	9	0.64	7	0.63
12	India	8	0.57	7	0.63
13	Bangladesh	7	0.50	7	0.63
14	Italy	7	0.50	3	0.27
15	Spain	6	0.43	4	0.36
16	Wales	6	0.43	-	-
17	France	5	0.36	8	0.72
18	New Zealand	5	0.36	5	0.45
19	China	5	0.36	3	0.27
20	Denmark	4	0.28	-	-
21	Thailand	-	-	6	0.54
22	Hungary	-	-	3	0.27
23	Nigeria	-	-	2	0.18

TABLE 8. MOST PRODUCTIVE JOURNALS IN THE WEB OF SCIENCE (WoS) AND SCOPUS

No.	Source title	No. of documents WoS	Impact factor 2010 JCR 2010	No. of documents Scopus	ScImago Journal Rank SJR 2010	Country
1	Journal of the American Oil Chemists' Society	168(1)	1.587	137 (1)	0.079	USA
2	Journal of Oil Palm Research	80(2)	1.487	Not indexed by Scopus	-	Malaysia
3	Bioresource Technology	73(3)	4.364 365	68(3)	0.175	Netherlands
4	European Journal of Lipid Science and Technology	69(4)	0.148	76(2)	0.093	Germany
5	Lipids	44(5)	2.151	41(6)	0.187	Germany
6	OCL Oleagineux Corps Gras Lipides	42(6)	-	35(9)	0.029	France
7	Food Chemistry	41(7)	3.458	54(4)	0.148	England
8	Energy Fuels	40(8)	2.444	Not indexed by Scopus	0.137	USA
9	Journal of Applied Polymer Science	40(8)	1.240	34(10)	0.077	USA
10	Fuel	37(10)	3.602	-	-	England
11	Journal of Food Lipids	37(10)	0.952	-	-	USA
12	Journal of Applied Sciences	Not indexed by WoS	-	44(5)	0.031	Pakistan
13	African Journal of Biotechnology	-	0.573	38(7)	0.038	Kenya
14	Journal of Agricultural and Food Chemistry	-	2.816	38(7)	0.144	USA
15	British Journal of Nutrition	-	3.072	34(10)	0.202	England

Nine of the top journals in WoS are published in US or Europe, with only one journal from Asia, *Journal of Oil Palm Research* (Malaysia). Scopus also includes journals from Pakistan and Kenya.

CONCLUSION

The literature on *E. guineensis* Jacq. and *E. oleifera* has shown a steady growth from the period of 1995-2010 as the number of publications has doubled in the last five years. Research productivity is evident in Asian countries especially Malaysia, Japan and India. Malaysia is the most prolific and productive country in producing literature related to palm oil, especially as it is the second largest producer of palm oil. Although Indonesia is the first producer and exporter ot palm oil, it has not been as active in scholarly productivity as Malaysia. Malaysia ranked first whereas Indonesia ranked 14 based on their scientific performance in WoS. This finding could be due to the fact that the top contributors to the *E. guineensis* Jacq. and *E. oleifera* literature in Malaysia are mainly from the research-based universities and R&D institutions. Findings from this study also showed that there are some well defined related areas from the food science and technology, chemical engineering and biotechnology disciplines which contribute to research and publication in palm oil. This shows that research in palm oil and oil palm is multi-disciplinary with a rapid growth in knowledge across disciplines.

Malaysia, which has been most prolific in publishing in this field, has been collaborating intensively with several other countries that have been prominent in their research output. Almost 16% of Malaysia's productivity has been written through collaboration with Japan, USA, England, Canada and Indonesia. Other Asian countries that collaborated with Malaysian researchers were form Singapore, Iran, India, Bangladesh, China and Thailand. Though France and Nigeria have a high level of productivity, collaboration between these countries and Malaysia has been quite low. Malaysian researchers should consider enhancing collaborating with these countries to extend the frontiers of expertise in this area of study.

Results of the study show that the most productive researchers and institutions in the area of *E. guineensis* Jacq. and *E. oleifera* are from Malaysia. As such, the ranking of prolific authors in WoS and Scopus do not differ highly, especially for the top 10 prolific authors. The less prolific authors have a higher number of publications indexed in Scopus mainly because of the coverage.

The study provides strong evidence that scientometrics is a sound undertaking at the country level. Despite the fact that the WoS and Scopus databases differ in terms of scope, volume of data and coverage policies (Lopez-Illescas *et al*., 2008), the outputs and impact of the countries obtained from the two databases are extremely correlated. This finding is consistent with that of Lopez-Illescas *et al.* (2009) in the field of oncology. Hence, the two databases offer robust tools for measuring science at the country level. Further research using comprehensive datasets should examine differences at the institutional level as well as in different fields – such as those of the social sciences and humanities – to test whether these results still hold at lower scales.

This study strongly supports the belief that the use of WoS and Scopus for analysing scientific productivity of researchers will yield almost similar results. Organisations and individual researchers may choose to use either one or both of these databases depending on the intent of the analysis. The research in *E. guineensis* Jacq. and *E. oleifera* has been encouraging and Malaysia will need to continue its efforts to retain its position as the most productive country. Moreover, the results of this study will make an important contribution to pave the way for future oil palm research directions and international collaboration with better management of funds and resources.

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REFERENCES

AL-QALLAF, C L (2009). A bibliometric analysis of the *Punica grantum* L. literature. *Malaysian Journal of Library & Information Science Vol. 14 No. 1*: 83-103.

ANWAR-MUMTAZ, A (2005). Nigella sativa: a bibliometric study of the literature on habbat al-barakah. *Malaysian Journal of Library & Information Science Vol. 10 No. 1*: 1-18.

ANWAR-MUMTAZ, A (2006). Phoenix dactylifera l: a bibliometric study of the literature on date palm. *Malaysian Journal of Library & Information Science Vol. 11 No. 2*: 41-60.

ARCHAMBAULT, É; CAMPBELL, D; GINGRAS, Y and LARIVIÈRE, V (2009). Comparing bibliometric statistics obtained from the Web of Science and Scopus. *J. American Society for Information Science and Technology Vol. 60 No. 7*: 1320-1326.

BAKKALBASI, N; BAUER, K; GLOVER, J and WANG, L (2006). Three options for citation tracking: Google Scholar, Scopus and Web of Science. *Biomedical Digital Libraries Vol. 3 No.7*. www.bio-diglib.com/content/pdf/1742-5581-3-7.pdf, accessed on 10 September 2012.

BALOG, C (1984). Authorship of papers dealing with different subjects in an agricultural journal. *Scientometrics Vol. 7 No. 1-2*: 105-110.

BALOG, C (1985). Agricultural research in New Zealand. *Scientometrics Vol. 8. No. 1-2*: 81-89.

BASIRON, Y (2011). Pakistan-Malaysia palm oil trade: why buy Malaysian palm oil. Paper presented at the Global Oils & Fats 7, Gaylord National Resort, National Harbour, MD, 2011 on 19-20 September 2011.

BORSI, B and SCHUBERT, A (2011). Agrifood research in Europe: a global perspective. *Scientometrics Vol. 86 No. 1*: 133-154.

BOSMAN, J; VAN MOURIK, I; RASCH, M; SIEVERTS, E and VERHOEFF, H (2006). Scopus reviewed and compared. The coverage and functionality of the citation database Scopus, including comparisons with Web of Science and Google Scholar. Utrecht University Library. http://igitur-archive.library.uu.nl/DARLIN/2006-1220-200432/Scopus doorgelicht & vergeleken - translated.pdf, accessed on 10 September 2012.

CHENG, H T (2010). Key sustainability issues in the palm oil sector: a discussion paper for multi stake holders consultations, report commissioned by World Bank Group. http://www.ifc.org/ifcext/agriconsultation.nsf/ Attachm entsByTitle/Discussion+Paper/$FILE/Discussion+Paper_FINAL.pdf, accessed on 10 September 2012.

FAO (2008). Agriculture statistics. FAO statistics division. http://faostat.fao.org, accessed on 10 September 2012.

FARAHAT, H (2002). Authorship patterns in agricultural sciences in Egypt. *Scientometrics Vol. 55 No. 2*: 157-170.

GARG, K C; KUMAR, S and LAL, K (2006). Scientometric profile of Indian agricultural research as seen through Science Citation Index Expanded. *Scientometrics Vol. 68 No. 1*: 151-166.

GIAN, S; MOIN, A and MOHAMMAD, N (2008). A bibliometric study of Embelia ribes. *Library Review Vol. 57 No. 4*: 289-297.

GORRAIZ, J and SCHLOEGL, C (2008). A bibliometric analysis of pharmacology and pharmacy journals: Scopus versus Web of Science. *J. Information Science Vol. 34 No. 5*: 715-725.

JACSO, P (2005). As we may search – comparison of major features of the Web of Science, Scopus, and Google scholar citation-based and citation-enhanced database. *Current Science Vol. 89 No. 9*: 1537-1547.

LaGUARDIA, C (2005). E-views and reviews: Scopus *vs*. Web of Science. http://www.libraryjournal.com/article/CA491154.html, accessed on 10 September 2012.

LOPEZ-ILLESCAS, C; MOYA-ANEGON, F and MOED, H F (2008). Coverage and citation impact of oncological journals in the Web of Science and Scopus. *J. Informetrics Vol. 2 No. 4*: 304-316.

LOPEZ-ILLESCAS, C; MOYA-ANEGON, F and MOED, H F (2009). Comparing bibliometric country-by-country rankings derived from the Web of Science and Scopus: the effect of poorly cited journals in oncology. *J. Information Science Vol. 35 No. 2*: 244-256.

MEHO, L I and YANG, K (2007). Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar. *J. American Society for Information Science and Technology Vol. 58 No. 13*: 2105-2125.

NASIR, M; HASSAN, H; HAMID, K A and AGHA, S S (1994). Bibliometric evaluation of agricultural literature published in Malaysia. *Scientometrics Vol. 29 No. 2*: 191-217.

POURIS, A (1989). A scientometric assessment of agricultural research in South Africa. *Scientometrics Vol. 17 No. 5-6*: 401-413.

SHARMA, R M (2009). Research publication trend among scientists of Central Potato Research Institute: a bibliometric study. *Annals of Library and Information Studies Vol. 56*: 29-34.

TIMMS, R (2007). Palm oil, the oil for the 21st century? *European Journal of Lipid Science Technology Vol. 109*: 287-288.

TORRES-SALINAS, D; LOPEZ-COZAR, C and JIMENEZ-CONTRERAS, E (2009). Ranking of departments and researchers within a university using two different databases: Web of Science versus Scopus. *Scientometrics Vol. 80 No. 3*: 763-776.

UNITED STATES DEPARTMENT OF AGRICULTURE (2012). Palm oil: world supply and distribution. http://en.wikipedia.org/wiki/Elaeis#cite_note-USDA2012-28, accessed on 10 September 2012.

VIEIRA, E S and GOMES, J A N F (2009). A comparison of Scopus and Web of Science for a typical university. *Scientometrics Vol. 81 No. 2*: 587-600.

WAKKER, E (2000). *Funding Forest Destruction –The Involvement of Dutch Banks in the Financing of Oil Palm Plantations in Indonesia.* AIDEnvironment, Contrast Advies, Telapak ed. Greenpeace Netherlands, Amsterdam. 132 pp.

ZHAO, D and STROTMANN, A (2010). Mapping the highly collaborative stem cell research field: adding last-author-based analysis to the author co-citation analysis family. *Proc. of the American Society for Information Science and Technology 2010 Annual Meeting.* 22-27 October 2010, Pittsburgh, PA, USA.