Research Productivity and Scholarly Impact of Forestry Researchers at Sokoine University of Agriculture: A Bibliometric Analysis

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Abstract

A bibliometric analysis was conducted to understand the research productivity and scholarly impact of forestry researchers at Sokoine University of Agriculture for the period of 1998 to 2013. Data were obtained using the Publish or Perish software that uses Google Scholar to retrieve scholars' publications, citations and related metrics. A total of 1031 publications were recorded for all forestry researchers, giving an average of 64.4 publications per year and an annual growth rate of 6.3%. The year 2008 had the most (12.7%) publications followed by 2007 with 9% of all publications while the year 2003 had the lowest (3.2%) number of publications. Majority (88.1%) of the publications were multiple-authored and the degree of collaboration was 0.88. The top ten ranked forestry researchers contributed nearly half (46.3%) of all publications; hence corroborating to the Lotka's Law of scientific productivity. However, these top ten scholars showed considerable variation since no single scholar maintained the same rank in all nine metrics. These findings suggest that many factors should be considered in combination when evaluating research performance. The study findings call for a paradigm shift for scholars to focus on the scholarly impacts of their publications.

Keywords: Research productivity, scholarly impact, forestry, bibliometrics

Background information

Evaluation of research performance can be conducted at various levels and for different purposes. Governments use research performance to get insights as to how far a country has progressed in research and development (Wickremasinghe, 2008), to plan and implement research policy, and for the value for money considerations. Funding organizations use research performance evaluations to decide the level of research funding (Arora *et al.*, 1998). At times, institutes that seek research funding are required

to provide evidence of their research accomplishments. In universities and research institutions, research performance is an important criterion for recruitment, promotion, rewards, professional recognition, workload decisions, and for allocation of resources and facilities. Research performance is also one of the most important indicators in ranking universities and research institutes. Moreover, disciplines' progress and reputation can be tracked based on their research performance (Ingram and Petersen, 1991; Read *et al.,* 1998). In addition, companies use research performance as a way of detecting expertise within universities, with subsequent hiring of faculty and graduates as consultants or employees (Gonzalez-Brambila and Veloso, 2007).

In principle, research performance has two components - productivity and impact. Traditionally, research productivity has been measured through the number of publications produced in a given time period. On the other hand, the quality of publications, which reflects the impact, is measured by how many times the publications are cited by other authors - the higher the number of citations, the higher the level of impact. That is to say, research performance has been determined by ascertaining the total number of publications and counting the number of times such publications have been cited by others. This is based on the fact that carrying out research and communicating the results go together, and that, any scientific research is often steered by previous similar works. However, in many cases a great deal of weight has been placed on the quantity of publications produced (Frost *et al*. 2007). Nevertheless, considering that research is a complex activity, a combined use of several performance indicators that consider its breadth is highly recommended (Van Leeuwen *et al*., 2003). Consequently, several sophisticated indicators have been developed in recent years for assessing and comparing performances of researchers, research groups, institutions or countries. Such indicators are a result of technological advancements that enable detailed analysis of data on publication and citation counts.

Research productivity and impact can be combined into a single index to determine research performance. Such indices include the h-index which integrates the number of publications and citation counts in a single number indicator. According to Hirsch (2005), "a scientist has index h if h of his or her Np papers have at least h citations each and the other (Np-h) papers have at most h citations each". The advantage of the h-index is that it combines an

assessment of both quantity (number of publications) and quality (citation counts) (Glänzel, 2006) - simultaneously conveying information about productivity and impact. That means, the h-index has been designed to improve upon simpler measures such as publication or citation counts. Large h scores indicate that a scholar has produced many publications that are well received within the field based on a high citation count. The h-index works properly when comparing scientists working in the same field over the same time period. Other variants of the h-index include the g-index which is a supplement to the h-index in that highly cited articles are given more weight. The contemporary h-index (hc-index) gives more weight to new publications. Furthermore, the HI-norm index normalizes the citation counts before the h-index is calculated by first dividing the citations by the number of authors for each individual work (Harzing, 2008).

Over the years, bibliometric techniques, which are part of scientometrics[1], have been important methods for evaluating research performance. According to Pritchard (1969), bibliometrics deal with the application of mathematical and statistical methods to analyze quantitative and qualitative aspects of publications. These techniques are used in identifying the most productive individuals or units, describing collaboration patterns, determining the popularity and impact of specific authors or publications, and in discovering research anomalies. Traditionally, the most commonly used sources of scientometric data for individual researchers are the Science Citation Index (SCI) and the Arts and Humanities Citation Index (A&HCI). Recent advances in information technologies have enabled innovative creation of large databases that incorporate publication and citation data from which, among others, a variety of metrics are derived. Consequently, new data sources including the Web of Science, Scopus, and Publish or Perish (PoP) have emerged in recent years.

The Publish or Perish (PoP) software, which was released in 2006, uses Google Scholar to obtain the number of publications and sources which cite them. Google Scholar is a search engine that utilizes a highly-guarded algorithmic procedure to identify scholarly works and index them accordingly. Hence, using Google Scholar to identify publications and citations allows for the inclusion of the author's entire body of published work rather than a

[1] Scientometrics is the science of measuring and analyzing science.

selected list of publications (Harzing, 2008). The PoP software produces a number of descriptive statistics for individual authors including the total number of papers, total number of citations, years since first publication, average number of citations per year, total citations per paper, total citations per author, and total papers per author. In addition, PoP calculates several indices including the h-index, g-index, Hc-index and HI-norm index. Comparative studies indicate that the PoP software retrieves more publications and citations compared to others such as Web of Science and Scopus (Bar-Ilan, 2008; Saad, 2006).

Forestry research in Tanzania dates back to 1893 when the first nursery was established near Dar es Salaam for testing tree species. Other notable developments in forestry research during the colonial period include the establishment of the Biological Research Station in 1902 in Amani, Tanga; shifting of the Amani Station to Muguga Kenya in 1948; and the establishment of Sivilcultural and Utilization Research Stations in Lushoto and Moshi respectively during the 1950s. Establishment of the Department of Forestry at the Morogoro campus of the University of Dar es Salaam in 1973 and its elevation to a division in 1974 further augmented forestry research in Tanznia. In 1980, the Tanzania Forestry Research Institute (TAFORI) was established to carry out and coordinate forestry research in the country. Following the establishment of the Sokoine University of Agriculture (SUA) in 1984, the then Forestry Division became the Faculty of Forestry (Nshubemuki, 1998; Abeli, 2000). In 1998, this Faculty underwent some transformations including renaming it to the Faculty of Forestry and Nature Conservation along with the establishment of the Department of Wildlife Management. At present, most forestry research in Tanzania is carried out at SUA mainly because there is a high number of researchers. SUA is the only university in the country with a dedicated faculty dealing with forestry and allied sciences.

This study was designed to understand the performance of forestry researchers at SUA for the period between 1998 and 2013. Forestry researchers in the context of this study include all academicians in the Faculty of Forestry and Nature Conservation at Sokoine University of Agriculture during the study period. Research performance was measured through the analysis of research productivity and scholarly impact of all researchers at the Faculty of Forestry and Nature Conservation. Specifically, the study analyzed the growth of

forestry scholarly literature, the year-wise break up of publications, and determined authorship patterns and the level of collaboration. The study also analyzed individual researchers' productivity and impact. The 16 years period was chosen in order to get insights about developments in forestry research since the Faculty of Forestry and Nature Conservation attained its current status. This study was also important in that no similar studies have been carried out at SUA and in Tanzania at large.

Literature review

Bibliometric methods have been used to measure the performance of researchers across disciplines around the globe. The field of forestry is no exception. A bibliometric analysis of the Journal of *Indian Forester* for the period between 1991 and 2000 indicated that the number of articles published yearly ranged between 114 in 1992 and 156 in 1996. Multiple-authorship was dominant (64.6%) and the degree of collaboration was 0.64 (Hazarika *et al.*, 2003). A bibliometric analysis of forestry research (1977-2007) in Bangladesh established a strong increase of forestry papers from 1998 to 2000 but they started to decrease in 2001 and again increased in 2005 due to various factors. Most of the published papers were multi-authored with degree of a collaboration of 1.0 (Miah *et al.*, 2008). Joshi *et al.* (2010) analyzed the global trends of forest fungal research during 1987 - 2008 and the results revealed that the numbers of publications had increased significantly especially during 2004 - 2008. Similarly, a bibliometric analysis of global biodiversity research during 1900 - 2009 revealed that the number of publications on biodiversity increased from 117 in 1980 to 7,533 in 2009 (Liu *et al.*, 2011). In a recent bibliometric analysis of global forest ecology research covering the period between 2002 and 2011, Song and Zhao (2013) found that the number of articles published annually grew at a stable rate.

Several bibliometric studies have been conducted in other fields as well. Among these studies, Sevukan *et al.* (2007) analyzed a total of 348 bibliographic records of plant sciences retrieved from Science Citation Index (SCI) during the interval 1997 to 2006. The study found that there was a sudden increase of publications in the years 1998 and 2003 while a decreasing trend was noted in the years 1999, 2002 and 2004 probably attributed to changes in funding sources for research. In his study of Plant Science research productivity in Chile during the past 20 years, Krauskopf (2008) noted that the

number of articles published within the Plant Science discipline grew throughout the 20-year period. The research productivity of social scientists at the Centre for Development Studies in India during 1998 – 2008 indicated that there were 599 publications (Sudhier and Abhila, 2011). Baby and Kumaravel (2012) examined the research productivity of Periyar University faculties in India during 1998 – 2010 and found that the growth of research has steadily increased from a single article in 1998 to 102 articles in 2010. Abramo *et al.* (2009) analyzed differences in research productivity of researchers in the scientific-technological disciplines of Italian universities. They confirmed the presence of significant differences in productivity between men and women although the differences were smaller than reported in the literature.

A number of studies have computed h-indices of individual researchers in different disciplines. Hirsch (2005) found that the h-indices of some prominent physicists ranged from 62 to 110; that of Nobel prize-winning physicists ranged from 22 to 79; and that of the top ten scholars in the life sciences ranged from 120 to 191. The study concluded that these were clearly huge figures and they reflect the publication habits in natural sciences. The h-indices of information scientists in the United Kingdom were found to range from 5 to 31 (Oppenheim, 2007) whereas the h-indices of 31 American information scientists ranged from 5 to 20 (Cronin and Meho, 2006). Saad (2006) found that the h-indices of consumer researchers ranged from 3 to 17 and Sidiropoulos *et al.* (2007) found that the h-indices of computer scientists ranged between 14 and 24. In evaluating the research productivity of Zahedan University of Medical Sciences (ZAUMS) from 1976-2011, Vatankhah (2012) found that the h-indices increased from 1 to 19 during the interval of the study. Abramo *et al* (2010) observed that the h-indices differ depending on what publications a database covers and analyzes. Generally, the literature confirms that the h-index is sensitive to the disciplinary background of researchers.

Other studies have ranked researchers according to various productivity and impact measures. Abrizah and Wee (2011) estimated the research productivity of Malaysia's computer science researchers using data from the Web of Science database during the period of 2000 to 2010. Among other findings, it was observed that 74.4 percent of 1662 authors published only one article and the most prolific author had 34 papers. Author productivity was not in agreement with Lotka's law. Using PoP, Khey *et al.* (2011) re-ranked the top

female academic "stars" in criminology and criminal justice that were identified by Rice *et al.* (2007). Among other things, the findings were largely similar to those of Rice *et al.* (2007), although some scholars did move up in some rankings. In a similar study, Copes *et al.* (2012) assessed the most productive scholars in criminology and criminal justice using various productivity measures. Through disaggregation of productivity measures by academic ranks, Copes *et al.* (2012) determined the most productive assistant professors, associate professors and full professors.

Notwithstanding the growing use of bibliometric studies to evaluate research performance, such studies are very scarce in Tanzania. An extensive literature search could only identify a study conducted by Ocholla *et al.* (2012) to compare the publication output and patterns of academic librarians in Eastern Africa from 2000 to 2009. The authors established that there were minimal publications over the course of ten years; most academic librarians preferred publishing individually; and that the most published authors were from the University of Dar es Salaam and Sokoine University of Agriculture in Tanzania. Hence, the present study would contribute to the scarce literature on scientometric studies in Tanzania.

Methods

This bibliometric analysis was conducted for five days from 9th to 13th September 2013. This short period was important because citation counts keep on accumulating. At first, names of forestry researchers were obtained from the Faculty of Forestry and Nature Conservation. Efforts were also made to obtain the names of scholars who worked with the Faculty for different periods between 1998 and 2013 but had left for various reasons. In total, 72 researchers were identified for this study.

Using the PoP software, author impact analyses of all 72 researchers were conducted for the 16 years period. The study utilized data that were publicly available in the web; meaning that any publications and citations that were not available on the web could not be retrieved. A search strategy was developed including all authors' names and their possible variants. Each individual scholar was entered into PoP to determine individual statistics. Search results were carefully refined to ensure that only works of intended persons were captured and duplicates were removed. Publications from homonym authors

were identified and removed. If questions arose on the validity of particular publications, these were re-searched via the web to determine if they were actually written by those particular authors. The results were sorted by years of publications in order to obtain the year-wise distribution. In the context of this study, the types of publications considered were journal articles, books, book chapters, conference papers and book reviews. The total number of authors for each publication was manually counted. For each scholar, the retrieved statistics included the total number of publications, total citation counts, average citations per paper, average papers per author, average citations per year, h-index, g-index, Hc-index and the HI-norm. The limitation of this study, as alluded to earlier, is that it only focused on publications that were retrieved by PoP through Google Scholar. This could however also be considered as a strength in terms of wider reach and impact.

Results and discussion

Based on the "all counting method" whereby each author receives a full count for joint pulications, a total of 1031 publications were recorded for all scholars at the SUA's Faculty of Forestry and Nature Conservation during the period between 1998 and 2013. This gives an average of 64.4 publications per year and an annual growth rate of 6.3%. The year-wise distribution shows that the year 2008 had the highest number (131; 12.7%) of publications followed by the year 2007 (93; 9%). The year 2003 had the lowest number (33; 3.2%) of publications (Table 1). Although publications were produced every year, the trend does not show a predictable growth pattern. This may raise some questions such as why would the number of publications rise in the year 2000 followed by a fall in the following years? Why was there a rise again in 2007 and 2008 which was followed by a fall by almost half in the following years? Partly, such trends might be attributed to the unreliable availability of research funds, which are often obtained through donor support. It could also be due to the fact that sometimes manuscripts take long time to be published in journals. It should be noted however that these publication data were extracted in September 2013; hence the total productivity of 2013 might be incomplete.

Table 1: Year-wise Distribution of Publications

Year	No of publications	Percent
1998	58	5.6
1999	42	4.1
2000	85	8.2
2001	60	5.8
2002	36	3.5
2003	33	3.2
2004	61	5.9
2005	75	7.3
2006	48	4.7
2007	93	9.0
2008	131	12.7
2009	71	6.9
2010	46	4.5
2011	59	5.7
2012	68	6.6
2013	65	6.3
Total	**1031**	**100.0**

Source: Google Scholar

With respect to the authorship pattern, the study findings indicate that the great majority (88.1%) of the publications were multiple-authored with over a fifth (21%) of the publications being contributed by three joint authors. A total of 194 (18.8%) publications had six or more authors and 188 (18.2%) publications had four joint authors. Only 11.9% of the total publications were single authored (Table 2). The ratio of team work to that of sole work was 7:1, indicating a very high level of collaboration in forestry research. These findings support previous studies such as those of Hazarika *et al.* (2003) and Miah *et al.* (2008) that established somehow similar authorship patterns and levels of collaboration in forestry research.

The degree of collaboration among forestry scholars was computed as the ratio of the total number of collaborative publications to the total number of publications (Subramanyan, 1983). The degree of collaboration in this study was 0.88; which again points towards a high level of teamwork. This can be attributed to the fact that forestry research is highly multidisciplinary in nature, which often calls for researchers from diverse specializations to share their expertise. However, this is contrary to Onyancha (2007) and Ocholla *et al.*

(2007) who reported that research collaboration in Africa is weak. Nonetheless, collaboration in research is often recommended as it enables researchers to share skills and techniques; enhances transferring of knowledge (especially tacit knowledge); brings about cross-fertilization of ideas; provides intellectual companionship; plugs the researcher into a wider scientific network; and enhances the visibility of research works (Katz and Martin, 1997). However, it is often difficult to determine the actual contribution of each scholar when they collaborate in writing a particular scholarly article.

Table 2: Authorship Pattern of Publications

No. of Authors	No. of publications	Percentage
Single Authors	123	11.9
Two Authors	166	16.1
Three Authors	216	21.0
Four Authors	188	18.2
Five Authors	144	14.0
Six or more Authors	194	18.8
Total	**1031**	**100.0**

Source: Google Scholar

The study findings in Table 3 indicate various productivity and impact measures of the top 10 ranked forestry researchers at SUA. The mean scores for various metrics for these top 10 ranked researchers were 47.7 publications, 325 citations, 8.36 cites/paper, 18.67 papers/author, 21.88 cites/year, h-index of 8.4, g-index of 15.4, Hc-index of 6.1 and HI-index of 5.7. These mean scores are higher than the overall means for all researchers. The top 10 ranked forestry researchers showed variation among productivity and impact measures since no single scholar maintained the same rank in all nine metrics. Hence, these findings support the argument that multiple measures should be employed when assessing scholars' performance. This means that there are no all-purpose indicators for research performance. This argument is supported by Martin (1997) who argued that research performance is a complex multifaceted endeavour that cannot be assessed using a single indicator.

When considering the number of publications, the top 10 ranked authors together contributed nearly half (477; 46.3%) of all publications with an average of 47.7 publications per author. These findings corroborate Lotka's Law of scientific productivity (Lotka, 1926) which postulates that large

proportions of authors tend to produce relatively few article equivalents, with the bulk of production being made by a small number of individuals. In this case, S.A.O. Chamshama was the most prolific author (69 publications) followed by R.E. Malimbwi (67 publications) and G.C. Kajembe (64 publications). However, when re-ranked based on citation counts, which indicates the usefulness of the publications, E.J. Luoga ranked the first (528 citations) followed by E. Zahabu (495 citations) and A.N. Songorwa (468 citations). Surprisingly, the top three scholars in terms of publications had fewer citations compared to some scholars with fewer publications. For example, Chamshama had the highest number of publications but dropped to the ninth position in terms of citations whereas Songorwa with 19 publications moved up from ninth to the third place. This confirms the fact that ones' citation counts depend on factors other than the number of publications. Such factors include the visibility and accessibility of journals where one publishes, quality of publications, author's integration into scientific networks, age of publications, the size of the scientific community (Creamer, 1998; Zuckerman *et al*., 1991), and the topic or issues which ones publishes.

With respect to the researchers' yearly impact, Luoga ranked number one with 37.71 cites per year, followed by Songorwa (31.20 cites per year) and Zahabu (30.94 cites per year). On the other hand, if one takes into account the number of cites given to each individual publication, Songorwa ranked the first followed by Luoga and J.J. Kashaigili with 24.63, 14.27 and 7.90 cites per paper respectively. The average number of citations per paper indicates the relative extent to which certain publications generate interest in the scientific community. The top three authors with the most papers per single author were Malimbwi (25.55 papers per author), Zahabu (25.15 papers per author) and Chamshama (23.50 papers per author). The number of papers per author is obtained by dividing each publication unit by the number of authors of that publication and summing the results over all publications.

Table 3: Rank-list of most productive authors

Author name	No. of publications	Citations	Cites/paper	Papers/author	Cites/year	H-index	G-index	HC-index	HI-norm	Overall rank
E. Zahabu	63 (4)	495 (2)	7.85 (4)	25.15 (2)	30.94 (3)	12 (1)	20 (2)	10 (1)	8 (1)	1
E.J. Luoga	37 (7)	528 (1)	14.27 (2)	12.87 (9)	37.71 (1)	9 (3)	22 (1)	7 (3)	8 (1)	2
J.J. Kashaigili	40 (6)	316 (4)	7.90 (3)	14.43 (8)	26.33 (4)	10 (2)	16 (4)	9 (2)	6 (2)	3
G.C. Kajembe	64 (3)	280 (5)	4.38 (8)	19.82 (5)	17.50 (5)	8 (4)	14 (5)	5 (5)	5 (3)	4
A.N. Songorwa	19 (9)	468 (3)	24.63 (1)	12.43 (10)	31.20 (2)	6 (6)	19 (3)	4 (6)	5 (3)	4
R.E. Malimbwi	67 (2)	252 (6)	3.76 (9)	25.55 (1)	15.75 (7)	7 (5)	12 (6)	5 (5)	5 (3)	5
P.K.T. Munishi	42 (5)	252 (6)	6.00 (6)	15.04 (7)	15.75 (7)	9 (3)	14 (5)	7 (3)	5 (3)	6
J.R. Kideghesho	34 (8)	244 (7)	6.97 (5)	20.98 (4)	17.43 (6)	8 (4)	14 (5)	6 (4)	6 (2)	6
S.A.O. Chamshama	69 (1)	206 (9)	2.99 (10)	23.50 (3)	12.88 (9)	8 (4)	11 (7)	4 (6)	4 (4)	7
G.C. Monela	42 (5)	213 (8)	4.84 (7)	16.90 (6)	13.31 (8)	7 (5)	12 (6)	4 (6)	5 (3)	8
Means	47.7	325	8.36	18.67	21.88	8.4	15.4	6.1	5.7	
Overall means	14.3	62.76	2.65	5.48	4.40	2.61	4.56	1.89	1.76	

Source: Google Scholar

Note: Number in parentheses is the scholars rank on that measure

The performance of forestry researchers was also measured on the basis of the h-index, which is regarded as the most robust and accurate measure of productivity and impact (Harzing, 2008). Zahabu had the highest h-index of 12, meaning that his 12 publications had been cited 12 or more times each, and the rest of the publications had fewer than 12 citations. Kashaigili ranked the second with the h-index of 10. These two were the only scholars with h-indices of at least 10. Since the h-index discounts the disproportionate weight of highly cited publications or papers that have not yet been cited, adjustments were made by giving more weight to the authors' highly cited publications (g-index). In this regard, Luoga had the highest g-index of 22 followed Zahabu (g-index 20) and Songorwa (g-index 19). The g-index therefore has a greater discriminatory power that makes it easier to compare performance.

When adjustments were further made to give more weight to newly published works (Hc-index), Zahabu (Hc-index 10) ranked the first followed by Kashigili (Hc-index 9). In this case, another scholar, P.K.T. Munishi, moved up sharing the third place with Luoga both having Hc-index of 7. The Hc-index often provides a slightly fairer comparison between junior and senior scholars. For junior scholars, the Hc-index is generally close to their regular h-index as most of their publications would be recent whereas for seniors, there can be substantial differences between the two indices as most papers included in their h-index are relatively old (Harzing, 2008). With regard to the HI-norm-index which evaluates the effects of co-authorship and estimates the per-author impact, Zahabu and Luoga occupied the first position with HI-norm index of 8 each whereas Kashaigili and J.R. Kideghesho ranked the second with indices of 6 each. Five scholars - Songorwa, Kajembe, Monela, Munishi and Malimbwi - tied at the third position with indices of 5 each.

Overall, Zahabu ranked the first followed by Luoga and Kashaigili. Whereas Zahabu maintained the first to fourth place in various metrics, Luoga fluctuated between the first and ninth position while Kashaigili fluctuated between the second and the eighth place. Interestingly, of the top ten most prolific researchers, five (Luoga, Malimbwi, Kajembe, Kashaigili and Zahabu) were from the same department - Department of Forestry Mensuration and Management. This ranking somehow echoes the ranking of SUA researchers in the Google scholar citations (SUA, 2013). It should be noted however that topping the list of researchers should not be considered that these scholars are

always more prolific; neither should it create any sense of superiority for these individuals. Instead, scholars should simply use this as a means to show how they fare among others in the discipline in a particular period of time. It should also be emphasized that ranking of researchers was based on publications and citations that were available online covering the period between 1998 and 2013. This means, some senior researchers could rank differently if their productivity and impacts were measured based on their career life and if offline publications and citations were retrieved.

Conclusion and recommendations

The study findings indicate that forestry researchers at SUA produced an average of 64.4 publications per year with an annual average growth rate of 6.3% from 1998 - 2013. However, there was inconsistent growth of research publications as the number of publications rose and fell. This situation can be attributed to, among other reasons, unreliable availability of research funds. The study findings also indicate a high level of teamwork as most publications were multi-authored. This high degree of collaboration is attributed to the multidisciplinary nature of forestry research. The top ten ranked forestry researchers showed considerable variation in various metrics as no single scholar maintained the same rank in all nine metrics. This supports the argument that multiple measures should be used when evaluating productivity and impact of scholars. Overall, Zahabu was the top ranking scholar.

The study findings suggest that several measures should be considered in combination when evaluating research performance of individual scholars. Relying on a single indicator such as total number of publications is inadequate because each indicator might present some drawbacks. The findings also suggest that researchers should publish substantial number of highly cited papers in order to improve their productivity and impact. This implies that researchers should publish their research papers in “visible” journals such as e-journals and particularly open access journals in order to receive high citation counts. This calls for a paradigm shift among researchers so that they focus on the scholarly impacts of their publications. Furthermore, since research in fields such as forestry has proved to be highly collaborative in nature, it is important for institutions to consider giving each author full credit when counting the publications. Future bibliometric research could include more parameters and involve all forestry researchers in Tanzania in

order to obtain a complete picture of forestry research in the country. A study can also be carried out to investigate factors that determine the research performance of individual forestry researchers. Further bibliometric studies can be conducted for other fields at SUA and Tanzania at large.

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