Analysis of journal content characteristics and metrics reported in the Clarivate Analytics Journal Citation Reports and Web of Science Core Collection Agricultural Engineering categories

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Abstract: The Clarivate Analytics Journal Citation Reports (JCR) and Web of Science (WoS) platforms are arguably the most influential journal citation/metric databases worldwide. Journals must first be indexed in the WoS Core Collection (CC) before being indexed in the JCR. The JCR and WoS platform are separate Clarivate Analytics products, but the JCR is included in the WoS platform for organizations that purchase both databases. The analysis for this study focused on citation data reported in the 2017 JCR (based on 2016 citation data) and other data reported in the WoS CC up to 2016. A total of 14 journals are indexed in the 2017 JCR agricultural engineering category; however, only 13 journals are analyzed in this because one journal was listed by mistake. Six of the 13 journals are published by large for-profit publishers (i.e., Elsevier B.V. or Springer Verlag) and the other seven are published by respective professional societies. The journals were analyzed as a function of type (specialty versus comprehensive), type of publisher and publication frequency, metrics such as the Journal Impact Factor (JIF), volumes of articles published by year and journal, and the source institutions and countries of published articles. Bioenergy- and industrial crop-focused journals included in the 2017 JCR agricultural engineering category manifest the strongest overall metrics, as evidenced by relatively high JIF scores: *Bioresource Technology* (4.917), *Biomass and Bioenerg*y (3.219) and *Industrial Crops and Products* (3.181). In contrast, the highest JIF reported in the 2017 JCR for a comprehensive agricultural engineering journal was 2.044 for *Biosystems Engineering*. During 2006 to 2016, the number of articles indexed in the Core Collection for the JCR agricultural engineering category rose from 1,124 to 4,078, an increase of 263%. Over 70% of the total articles published in 2016 were published in the three bioenergy- or industrial-crop focused journals. The top three countries that published the highest levels of WoS Core Collection agricultural engineering articles in 2016 were China (1132), United States (669) and Brazil (474). The similar top publishing institutions were the United States Department of Agriculture (USDA; 136), Chinese Academy of Sciences (CAS; 136) and Indian Council for Scientific and Industrial Research (CSIR; 79). The results of the study also show that publishing by Chinese scientists in the 13 journals indexed in the JCR Agricultural Engineering (AE) category is rapidly increasing, with seven research institutions ranked in the global top 20 in 2016, based on studies published in journals indexed in the JCR agricultural engineering category. The analysis also reveals that the specialty journals (e.g., the three bioenergy-focused journals) are not directly comparable with the comprehensive agricultural engineering journals and should potentially be excluded from future versions of the JCR and WoS CC AE categories.

Keywords: Web of Science, JCR, agricultural engineering, impact factor, USDA, CAS, comprehensive journals, specialty
DOI: 10.25165/j.ijabe.20181105.3083

Citation: Wang Y J, Gassman P W, Wang Y K, Pu Y J. Analysis of journal content characteristics and metrics reported in the Clarivate Analytics Journal Citation Reports and Web of Science Core Collection Agricultural Engineering categories. Int J Agric & Biol Eng, 2018; 11(5): 1–26.

1 Introduction

The origins of the field of Agricultural Engineering (AE) can be traced to early innovations developed by ancient civilizations, including water technologies used by pre-Roman cultures[1], irrigation systems developed in Mesopotamia[2] and Mesoamerica[3], the use of channels, tunnels and aqueducts in Etruscan[4] and Roman[5] cultures, agricultural terraces in Mesoamerica[6] and wooden wheat harvesting machines used in the Roman Empire[7]. The influence of engineering in agriculture expanded during the industrial age, as evidenced by more advanced agricultural machinery such as the mechanical reaper[8], seed drill and horse drawn hoe[9] and improved horse drawn plows[7,9], cotton gin[10], steam plow and combine harvester[11], and other machinery[7].

The Agricultural Engineers Association, a trade group established in 1875 to represent agricultural machinery manufacturers and distributors in the United Kingdom[12], is likely one of the first organizations to formally the term "agricultural engineering". The first university AE Department was established

Received date: 2017-04-26 **Accepted date:** 2018-09-15
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in 1905 at Iowa State University[13], followed by numerous similar departments at other U.S. Land Grant Institutions[14-17]. Similar development of the AE field occurred in other countries, such as the Institute of Agricultural Engineering (IAE) that was formed in 1924 at Oxford University in the United Kingdom that later evolved into the Silsoe Research Institute[18,19]. The origins of modern AE education in China occurred in the late 1940s, which included educational exchanges and other interactions with U.S. universities and companies[20,21]. These developments led to the establishment of the first Chinese university AE departments and colleges during the early 1950s[22].

The first reported AE society was the American Society of Agricultural Engineers (ASAE), which was established in 1907, and later evolved into the American Society of Agricultural and Biological Engineers in 2005[13]. Various societies and related groups later formed to support the discipline in different countries and regions, such as the European Society of Agricultural Engineers (EurAgEng)[23], Chinese Society of Agricultural Engineering (CSAE)[24] and the Society for Engineering in Agriculture in Australia (SEAg)[25]. At present, 33 such organizations are members of the International Commission of Agricultural Engineering (CIGR)[26], which was formed in 1930 at the First International Congress of Agricultural Engineering (CIGR)[27].

The first AE journal identified in the literature was *Agricultural Engineering*, which ASABE started publishing in 1920[28] (and which later evolved into more of a news magazine until publication ceased in 1994). The society later started publishing *Transactions of the ASAE* in 1958[29], which became *Transactions of the ASABE* in 2006, and added *Applied Engineering in Agriculture* in 1985[30]. The official journal of EurAgEng is *Biosystems Engineering*[[31], which was previously called the *Journal of Agricultural Engineering Research* between 1956 and 2001[32]. Over 30 other AE journals are currently published including the *International Journal of Agricultural and Biological Engineering*[33], *Canadian Biosystems Engineering*[34], *Agricultural Engineering International: CIGR Journal*[35], *Journal of Agricultural Engineering*[36] and *Engenharia Agr ̀cola*[37].

The majority of the journals published within the AE field can be termed "comprehensive AE" journals, which refers to the wide range of disparate sub-disciplines that are represented within the overall field such as: (1) animal, plant and facility systems; (2) power and machinery systems; (3) natural resources and environmental systems; (4) biosystems, biological and ecological engineering; and (5) agro-product and food processing systems[33]. There is some overlap in research topics that are relevant to various agricultural sub-disciplines as discussed below in Section 2.1, but most of the broad sub-disciplines are generally distinct fields which results in limited cross-interaction with other major agricultural engineering sub-disciplines. Thus comprehensive AE journals are relatively unique publishing platforms within the overall domain of scientific journals, due to the extremely broad range of sub-topics that are covered in such journals.

Dozens of metrics have been developed over the past several decades to provide different measures of the relative influence of specific scientific journals including AE journals[38-44]. The most influential of these metrics is the journal impact factor (JIF), which was initially introduced in conceptual[45] and prototype[46], and was later formally incorporated within the first Journal Citation Report (JCR) that was published in 1975[47], as part of the overall data reported by the Institute for Scientific Information (ISI) that Dr. Eugene Garfield started in 1960[47]. The Thomson Corporation (which later became Thomson Reuters) purchased ISI along with the JCR and other citation products in 1992[48]. Several of those key citation products were eventually included in Thomsen Reuter's Web of Science (WoS) platform, which they sold in 2016 along with related products to two private equity funds[49]. As a result, a new firm called Clarivate Analytics was formed[50], which currently manages the WoS platform including the JCR and related citation databases.

The current WoS platform consists of two major databases referred to as the Core Collection (CC) and All Databases, the latter of which includes CC-indexed journals as well as additional journals (and citations) recorded in several other specialist and regional indexing databases; e.g., BIOSIS Citation Index, CAB Abstracts, Inspec, and the Chinese Science Citation Database[51]. The WoS CC contains citation data for over 18 000 journals in four main databases[51]: Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI), Arts & Humanities Citation Index (AHCI) and the Emerging Sources Citation Index (ESCI). Selected books and conference proceedings articles are also indexed in the CC via the Conference Proceedings Citation Index (CPCI) and Book Citation Index[51]. The CPCI is further partitioned into the Conference Proceedings Citation Index, Science (CPCI-S) and Conference Proceedings Citation Index, Social Science and Humanities (CPCI-SSH)[52,53]. The 2017 JCR, which reports 2016 citation data and is a component of the WoS[54], consists of a total of 11 459 journals indexed in the SCIE and/or SSCI in one or more of 236 topical categories in the JCR[55]. Over 8850 and 3200 journals are indexed in the respective SCIE and SSCI databases according to Clarivate Analytics[51].

AE journals were originally grouped within a generic Engineering category in the 1997 JCR and then subsequently re-categorized to a specific AE category in the 2000 JCR (see search information in Appendix A). Nine journals were grouped in the 2000 JCR AE journal category, which expanded to 14 reported journals starting with the 2015 JCR. However, *The Journal of the Korean Society for Applied Biological Chemistry* was listed by mistake due to an unknown error in both the 2016 and 2017 JCR (Hubbard, S. 2018. Personal communication. Content Team Lead, JCR, Philadephia, PA: Clarivate Analytics). Thus the analyses performed for this study is limited to the 13 journals that were correctly indexed in the 2017 JCR (but versions of selected tables and figures are provided in Appendix B that include data for *The Journal of the Korean Society for Applied Biological Chemistry*).

A curious mix of comprehensive and "specialty topic" journals have been represented in the JCR AE (and WoS CC AE) category since its inception in 2000. Specialty topic journals are defined here as being focused on a more narrow set of research topics that do not provide a forum for the broad range of topics published in comprehensive agricultural engineering journals, such as described for the journals *Industrial Crops and Products*[56] and *Paddy Water and Environment*[57]. At present, the 13 journals in the 2017 JCR agricultural engineering journal category are generally split between comprehensive AE journals and specialty topic journals. A total of 13 metrics including the JIF are reported in the JCR for each journal in the AE category and the journals included in the other 235 JCR categories.

Hall and Olsen[58] compiled 17 chapters of material focused on the influence and application of AE literature at that time. Those 17 chapters included an overview of the types of literature published by ASAE[59], and the journals or other literature that served as the primary publication outlets and sources of citations

for scientists conducting AE related research[60]. Reviews of AE journals have been recently reported in Chinese[61,62]. However, no known studies have since been published in English that focus on the characteristics and impacts of key AE engineering journals.

Thus the goal of this study is to review the structure and impacts of the 13 journals, and the utilization of those journals in the research community, that are currently indexed in the 2017 JCR and WoS CC AE categories (and reflect 2016 citation data). Specifically, the objectives are: (1) to describe the characteristics of the 13 journals based on type of publisher, focus of the journal (comprehensive versus specialty), research topics covered in each journal, total annual articles published and other factors; (2) compare the relative impact of the 13 journals as a function of 2017 JCR JIF, 5-year JIF and total cites metrics, as well as long-term JIF trends; (3) describe long-term publication trends among the 13 journals as well as national, institutional publication and other trends based on data reported in the WoS CC AE category; and (4) discuss the need for possible revisions to the current JCR and WoS CC AE categories to more accurately reflect the impact of comprehensive AE engineering journals. The 2018 JCR, which reports 2017 citation data, was released during the final stages of the preparation of this study. JIF data based on the 2018 JCR AE journals category are reported in Appendix C.

2 Description and key metrics for JCR agricultural engineering journals

2.1 Characteristics of JCR AE category journals

The 13 journals indexed in the JCR AE category are listed in Table 1 per several criteria including classification, JIF rank, journal name, sponsoring society (if applicable), publisher, publication frequency and publication model (traditional versus open access). The journals are partitioned in Table 1 on the basis of being classified as specialty journals versus comprehensive journals and are further ordered within the two main subsections of the table as a function of 2016 JIF values (see Section 2.2 for specific JIF values). The JCR abbreviated names (Table 1) are used in the remainder of the discussion when referencing one or more of the 13 specific journals.

Table 1 Classifications, JIF rank, journal titles, professional society, publisher and publication characteristics for the 13 journals indexed in the 2017 JCR Agricultural Engineering Category[a,b]

Classification	JIF Rank[c]	Full journal title	Abbreviated journal title[d]	Society[e] (country)	Publisher (country)	Publication frequency	Initial year	Publication model[f]
Specialty topic agricultural engineering journals (abbreviation: specialty)	1	Bioresource Technology	Bioresource Technol	NA[g]	Elsevier B.V. (The Netherlands)	< monthly	1991	Traditional (supports OA)
	2	Biomass & Bioenergy	Biomass Bioenerg	NA	Elsevier B.V. (The Netherlands)	Monthly	1991	Traditional (supports OA)
	3	Industrial Crops and Products	Ind Crop Prod	NA	Elsevier B.V. (The Netherlands)	Monthly to < monthly	1992	Traditional (supports OA)
	5	Journal of Irrigation and Drainage Engineering	J Irrig Drain Eng	ASCE (United States)	ASCE (United States)	Monthly	1956	Traditional
	6	Aquacultural Engineering	Aquacult Eng	AES (United States)	Elsevier B.V. (The Netherlands)	Quarterly to bimonthly	1982	Traditional (supports OA)
	8	Paddy and Water Environment	Paddy Water Environ	PAWEES (Japan)	Springer Verlag (Germany)	Quarterly	2003	Traditional (supports OA)
Comprehensive agricultural engineering journals (abbreviation: comprehensive)	4	Biosystems Engineering	Biosyst Eng	EurAgEng (United Kingdom)	Elsevier B.V. (The Netherlands)	Monthly	2002[h]	Traditional (supports OA)
	7	Transactions of the ASABE	T ASABE	ASABE (United States)	ASABE (United States)	Bimonthly	1958	Traditional
	9	International Journal of Agricultural and Biological Engineering	Int J Agr Biol Eng	CSAE & AOCABFE (Peoples R China)	CASE (Peoples R China)	Bimonthly	2008	Open access
	10	Revista Brasileira de Engenharia Agricola e Ambiental	Rev Bras Eng Agr Amb	NA	DEAg-CTRN-UFCG[i] (Brazil)	Monthly	1997	Open access
	11	Applied Engineering in Agriculture	Appl Eng Agric	ASABE (United States)	ASABE (United States)	Bimonthly	1985	Traditional
	12	Engenharia Agricola	Eng Arg-Jaboticabal	SBEA (Brazil)	SBEA (Brazil)	Bimonthly	1972	Open access
	13	AMA-Agricultural Mechanization in Asia Africa and Latin America	AMA-Arg Mech Asia Af	NA	Shin-Norinsha Co., Ltd. (Japan)	Quarterly	1971	Traditional

Note: [a] The 2017 JCR[54,55] reports citation data recorded in 2016. [b] *The Journal of the Korean Society for Applied Biological Chemistry* is also indexed in the 2015 and 2016 JCR Agricultural Category. However, this occurred due to an unknown error (Hubbard, S. Personal communication. Content Team Lead, JCR, Clarivate Analytics, Philadephia, PA). Thus no further reporting of data for the journal is included in this study. [c] JIF rank is reported in the 2017 JCR as listed in Table 5 in section 2.2. [d] Abbreviated journal title names as reported in the JCR Agricultural Engineering category. [e] Definitions of society abbreviations: AES = Aquacultural Engineering Society (https://www.aesweb.org/); ASCE = American Society of Civil Engineering (https://www.asce.org/); PAWEES = International Society of Paddy and Water Environment Engineering (http://pawees.net/); EurAgEng = European Society for Agricultural Engineers (https://www.eurageng.eu/); CSAE = Chinese Society of Agricultural Engineering (http://www.csae.org.cn/); AOCABFE = Association of Overseas Chinese Agricultural, Biological, and Food Engineers (http://aocabfe.com/); ASABE = American Society of Agricultural and Biological Engineers (http://www.asabe. org/); SBEA = Brazilian Association of Agricultural Engineering (http://www.sea.org.br/). [f] Traditional = no articles are published open access; Traditional (supports OA) = open access articles are possible for a fee; open access = all of the articles are published open access (also requires publication fees). [g] NA = not applicable. [h] *Biosyst Eng* was previously published as the *J Agr Eng Res* between 1956 and 2001[32]. [i] DEAg-CTRN-UFCG = Departamento de Engenharia Agrícola, Centro de Tecnologia e Recursos Naturais, Universidade Federal de Campina Grande (http://www.scielo.br/revistas/rbeaa/iaboutj.htm).

The journals with the greatest longevity are *J Irrig Drain Eng*, *T ASABE* and *Biosyst Eng*, which were first published in the late 1950s (Table 1); *Biosyst Eng* was originally *J Agr Eng Res* (Table 1). The other journals were initiated anywhere between the early 1970s and the first decade of the 21st century. Nine of the journals are sponsored by various professional societies such as ASABE and EurAgEng. Six of the journals are published by either Elsevier B. V. or Springer Verlag, which are dominant for-profit publishers[63], including the journals sponsored by the Aquacultural Engineering Society (AES), International Society of Paddy and Water Environment Engineering (PAWEES) and EurAgEng (Table 1). Both *Rev Bras Eng Agr Amb* and *Eng Arg-Jaboticabal* originally published accepted studies predominantly in Portuguese. However, *Rev Bras Eng Agr Amb* converted to exclusively English articles in the 2016 publication year[64] and *Eng Arg-Jaboticabal* has essentially made the same conversion, although the instructions to authors indicate that articles written in Portuguese and Spanish are also accepted[65].

The majority of the journals publish either exclusively in a traditional mode, which does not support open access publishing, or publish predominantly in a traditional mode but also provide options for publishing articles in open access formats ("Traditional (supports OA)" in Table 1). The fees for publishing open access articles in the Elsevier journals (Table 1) range from \$2750 for *Biosyst Eng*[66] to \$3600 for *Aquacult Eng*[67]. Open access articles published in Springer journals are charged a standard fee of \$3000[68]. In contrast, all articles are published in open access format in *Int J Agr Biol Eng*, *Rev Bras Eng Agr Amb* and *Eng Arg-Jaboticaba* for varying submission and/or publication fees as described on the respective journal websites, which are typically considerably less than those charged by Elsevier and Springer. All of the journals, which publish partially or totally in open access mode, publish open access articles based on Creative Commons licensing agreements[69]. In general, the JCR AE category publication trends confirm the growing influence of disseminating scientific research via open access publishing formats.

The publication frequency (Table 2) ranges from quarterly (*Paddy Water Environ* and *AMA-Arg Mech Asia Af*) to multiple times per month (*Bioresource Techno*; i.e., "< monthly"). *Ind Crop Prod* and *Aquacult Eng* have manifested some irregular publication frequency patterns in recent years. Considerable year-to-year fluctuation can also occur in the number of articles published for a given journal as evidenced by the total articles published in 2015 versus 2016 (e.g., *Ind Crop Prod* and *T ASABE*). The total articles published on an annual basis varies dramatically across the 13 journals as shown by 2015 and 2016 WoS Core Collection data (Table 2). The lowest level of published articles per year occurred for *Paddy Water Environ*, *AMA-Arg Mech Asia Af* and *Aquacult Eng*, which is consistent with the lower frequency of published issues for those three journals. At the opposite extreme, the total articles published per year in *Bioresource Technol* and *Ind Crop Prod* are roughly factors of 30 and 15 greater as compared to the three journals with the lowest publication totals. The top three journals (*Bioresource Technol*, *Ind Crop Prod* and *Biomass Bioenerg*) comprised over 65% of the total publications in both 2015 and 2016, revealing that the scientific community intersecting with those journals is relatively huge compared to traditional AE disciplines. This is further confirmed by the data in Table 2, which indicates that the seven comprehensive AE journals (Table 1) represent 21% to 25% of the total JCR AE category publications in 2015 and 2016.

Strong contrasting topical differences between the comprehensive AE journals (Table 1) and the specialty journals can also be discerned between Tables 3 and 4. Table 3 presents broad subdisciplines and corresponding example research topics, that are typically within the domain of overall material that could be published in a given issue of a comprehensive AE journal[33]. Some overlap may occur in research focus between the broad subdisciplines listed in Table 3. However, the majority of research that occurs within each broad subdiscipline occurs independently of research conducted in the other subdisciplines. The exact research topics that are of primary interest varies some between the different comprehensive journals (Table 1). This is especially true of *AMA-Arg Mech Asia Af*, which publishes research focused mainly on agricultural machinery use in developing regions and thus could be viewed as a specialty journal. However, there is no other logical JCR category that *AMA-Arg Mech Asia Af* could be slotted in. Overall, the comprehensive journals are characterized by the types of unique expansive research realms listed in Table 3.

Table 2 Total number of articles published in each of the 13 journals indexed in the JCR Agricultural Engineering category for 2015 and 2016[a]

JCR journal title	Total articles	Proportion /%	Total articles	Proportion /%
	2015		2016	
Bioresource Technol	1537	37.7	1615	40.12
Ind Crop Prod	937	23.0	713	17.71
Biomass Bioenerg	356	8.7	317	7.88
Biosyst Eng	164	4.0	193	4.80
Aquacult Eng	52	1.3	45	1.12
J Irrig Drain Eng	158	3.9	176	4.37
Int J Agr Biol Eng	106	2.6	133	3.30
T ASABE	154	3.8	203	5.04
Paddy Water Environ	51	1.3	47	1.17
Rev Bras Eng Agr Amb	180	4.4	180	4.47
Appl Eng Agric	95	2.3	104	2.58
Eng Agr-Jaboticabal	113	2.8	125	3.11
AMA-Agr Mech Asia Af	53	1.3	63	1.57
Total	4078	100	4025	100

Note: [a] Reported in the WoS CC AE data[51].

Table 4 presents the specific research topics that are covered in the seven specialty journals. The topical coverage provided by each of the seven specialty journals is very narrow as compared to the broad subdisciplines covered by most of the comprehensive AE journals. In addition, these specialty journals are categorized in at least one other JCR category (Table 4), indicating that these journals are of primary interest to other distinct scientific disciplines. However, *Biosyst Eng* is the only comprehensive AE journals (Table 1) categorized in another JCR category (Agriculture, Multidiscplinary), for reasons that are not clear relative to the other comprehensive AE journals. The specific research topics and additional categorizations of the specialty journals underscore the distinct differences of those journals versus the comprehensive AE journals, which is addressed in more detail below.

Table 3 Example broad subdisciplines and research topics represented in comprehensive agricultural engineering journals[a]

Broad subdisciplines	Example research topics
Applied Science, Engineering and Technology	Applied physics, biomaterial sciences, biology, biological engineering fundamentals, bioprocessing, biological kinetics, biosystem modeling
Animal, Plant and Facility Systems	Structures for animal housing, plant production, commodities storage, environmental air quality, environment of animal and plant structures, plant growth chambers, greenhouses, high tunnels, manure management
Power and Machinery Systems	Design and manufacturing, mechanization and automation, man-machine system interaction, precision agriculture and emerging technologies, tractor & implement hydraulics, mechanical aspects of harvesting
Natural Resources and Environmental Systems	Design and installation of structural conservation practices, irrigation systems, applications of ecohydrological models, environmental impacts of cropping and management systems, applications of GIS and RS, water quality
Information Technology, Sensors and Control Systems	Artificial intelligence, advanced sensing technology, biosensors and system control, computer aided systems, GIS, GPS, RS agricultural applications
Biosystems, Biological and Ecological Engineering	Biorenewables production and processing, convert bio-based resources to food and fuel, biosensors, water quality, environmental impacts of the bioeconomy
Renewable Energy and Material Systems	Innovative energy sources, renewable energy technologies, biomass production, handling, utilization, energy efficiency and conservation
Agro-product and Food Processing Systems	Post-harvest handling and storage, food and biological processing engineering, imaging and sensing technology, food safety and security, food technology
Structures and Bio-environmental Engineering	Environmental control of animal and plant structures, imposed loads on structures, materials of construction; agricultural waste management
Safety, Health and Ergonomics	All engineering aspects of ergonomic human safety and health for users of equipment systems and facilities in agriculture

Note: [a] See Table 1 for additional details regarding the specific comprehensive agricultural engineering journals.

2.2 Definitions of JCR Total Cites, JIF and 5-Year JIF metrics

As noted previously, 13 different metrics are reported for each journal included in the JCR[40]. Three key metrics from that overall set are analyzed here for the 13 journals in the JCR AE category: total cites, JIF and 5-year JIF.

The JCR total cites (TC) metric is defined in documentation for the database as: "The total number of times that a journal has been cited by all journals included in the database in the JCR year"[70]. This is a straight forward metric that is calculated on the basis of citations in a given year to all of the articles that have been published in the respective journal for all of the years that the journal has been indexed in the WoS. The TC for a given journal in a given year can be influenced by a number of factors and is especially affected by the total number of articles that are typically published on an annual basis in the specific journal. The TC metric can show the degree that the journal is used and valued, and the role and status in scientific communication.

Table 4 Primary research areas covered by specialty topic journals[a] in the JCR Agricultural Engineering category

Journal[b]	Additional JCR categories	Primary research topics
Bioresource Technol	Biotechnology & Applied Microbiology; Energy & Fuels	Biofuels, bioprocesses and bioproducts, biomass and feedstocks utilization, thermochemical conversion of biomass, biological waste treatment
Ind Crop Prod	Agronomy	Industrial (i.e., non-food/non-feed) crops and products, including aspects of cultural practices, germplasm development and breeding, new crop types
Biomass Bioenergy	Biotechnology & Applied Microbiology; Energy & Fuels	Biomass, biological residues, bioenergy processes, bioenergy utilization, biomass and the environment
Aquacult Eng	Fisheries	Engineering and design, construction experience and techniques, in-service experience, commissioning and operation, materials selection and uses, and quantification of biological data/constraints, related to aquaculture facilities
J Irrig Drain Eng	Engineering, Civil; Water Resources	All phases of irrigation, drainage, engineering hydrology, and related water management subjects including water quality, groundwater and surface water
Paddy Water Environ	Agronomy	Irrigation and drainage, soil and water conservation, land and water resources management, paddy multi-functionality, and other aspects of paddy farming

Note: [a] See Table 1 for additional details about each journal. [b] Sources: Bioresource Technol (https://www.journals.elsevier.com/bioresource-technology/); Ind Crop Prod (https://www.journals.elsevier.com/industrial-crops-and-products); Biomass Bioenergy (https://www.journals. elsevier.com/biomass-and-bioenergy); Aquacult Eng (https://www.journals.elsevier.com/aquacultural-engineering); J Irrig Drain Eng (https://ascelibrary.org/page/jidedh/editorialboard); Paddy Water Environ (https://link.springer. com/journal/10333).

The JIF is determined for a journal in a specific year by: (1) determining the total number of citations received by articles published in the journal during the preceding two years (during the year that the JIF is calculated for), (2) summing the total number of articles that were published in the journal during the preceding two years, and (3) finally dividing the total citations by the total number of articles[40,52,71]. For example, a JIF for a hypothetical journal would be calculated as follows for the year 2016:

$$JIF\_2016 = (Citations\_(2014+2015))/(Publications\_(2014+2015)) \quad (1)$$

where, JIF_2016 = the JIF calculated for the journal in 2016, Citations_(2014+2015) are the total number of citations received by articles published in the journal during 2014 and 2015, and Publications_(2014+2015) are the total articles that were published in the journal during 2014 and 2015. As noted previously, the JCR data published each year includes JIF metrics only for journals that are indexed in the WoS SCIE and/or SSCI databases. However, citations recorded for a specific journal in either of those two databases can be accrued from any of the five WoS journal or proceedings index databases; i.e,, SCIE, SSCI, ACHI, CPCI-S or

CPCI-SSH[52]. It can be seen that the citation peak period, citation frequency and the total published articles are the three main factors that influence the JIF, and those three factors can be affected by numerous sub-factors.

The 5-year Journal Impact Factor (5-year JIF) is calculated in the same way that the standard JIF is calculated except that a five-year time period is used rather than a two-year period[40,72]. Thus the 5-year JIF is a measure of impact for a given journal that is calculated by: dividing the total citations to articles published during the preceding five years in the journal by the total number of articles published in that journal during the previous five years. The 5-year JIF can potentially provide more insight into broader long-term citation patterns and can also mitigate, to some extent, extreme JIF fluctuations caused by one or more very highly cited articles; e.g., see discussion about such fluctuations provided by Liu et al.[73] However, 5-year JIF values are not reported for journals that have been indexed in the JCR for less than five years.

2.2 2017 JCR AE category total cites, JIF and 5-year JIF metrics

Table 5 shows the 2016 total cites, JIF and 5-year JIFs reported for the 13 journals in the 2017 JCR AE category (Table 1). The journals are ranked in Table 5 on the basis of the highest JIF (*Bioresource Technol*; 5.651) to the lowest JIF (*AMA-Agr Mech Asia Af*; 0.118) values. The other metrics generally follow the same ranking as the JIF values although there are notable exceptions; e.g., the strong 5-year JIF for *Aquacult Eng* and the relatively high level of total cites reported for T ASABE. The 5-year JIF is higher than the standard JIF for the majority of the 13 journals although the reverse relationship is evident for *J Irrig Drain Eng* and *AMA-Agr Mech Asia Af* , which indicates an increasing level of citations during 2014 and 2015 for both journals. There is no 5-year JIF reported for *Int J Agr Biol Eng* because the journal was indexed for the first time during 2013 in the WoS CC (thus lacking sufficient data).

Table 5 Total cites, JIF and 5-year JIF values reported for the 13 JCR Agricultural Engineering category journals for citation data recorded in 2016[a]

Journal title	Total cites	JIF	5-Year JIF	Classification
Bioresource Technol	93 612	5.651	6.102	specialty
Biomass Bioenerg	18 312	3.219	4.186	specialty
Ind Crop Prod	15 116	3.181	3.577	specialty
Biosyst Eng	4495	2.044	2.238	comprehensive
J Irrig Drain Eng	3434	1.983	1.842	specialty
Aquacult Eng	1917	1.559	2.004	specialty
T ASABE	8412	0.975	1.264	comprehensive
Paddy Water Environ	609	0.916	1.218	specialty
Int J Agr Biol Eng	503	0.835	-	comprehensive
Rev Bras Eng Agr Amb	1311	0.608	0.78	comprehensive
Appl Eng Agric	1590	0.505	0.667	comprehensive
Eng Agr-Jaboticabal	686	0.353	0.59	comprehensive
AMA-Agr Mech Asia Af	106	0.118	0.087	comprehensive

Note: [a] 2016 statistics are reported in the 2017 JCR published by Clarivate Analytics[54,55].

The rankings presented in Table 5 reveal the dominance of both specialty journals and journals published by Elsevier B.V. (Table 1), among the 13 journals included in the current JCR AE category. Specialty journals occupy five of the top six ranked journals while five of the comprehensive AE journals are ranked among the bottom seven journals, including the bottom four journals. The strong metrics for the top two journals, *Bioresource Technol* and *Biomass Bioenerg*, confirm the intense interest across a sizable subset of the scientific community regarding biofuels, bioenergy processes and related topics. The 2016 JIF reported for *Ind Crop Prod* was just slightly below *Biomass Bioenerg* (3.181 versus 3.219), but distinctly stronger total cites and 5-year JIF metrics were reported for *Biomass Bioenerg* in 2016. The relative strengths of the JIFs and other metrics for *Ind Crop Prod*, *J Irrig Drain Eng* and *Aquacult Eng* reveal that the specific topics published in those three specialty journals are of strong interest to important subsets of the overall scientific community.

Five of the top six ranked journals shown in Table 5 were published by Elsevier B.V., with the lone exception being *J Irrig Drain Eng* which is published by the American Society of Civil Engineers (Table 1). This is likely due primarily to the topical coverage of the five journals, although it may also reveal that there is wider accessibility and/or familiarity across the scientific community regarding Elsevier B.V. journals, even though none of the journals publish in full open access format. *Biosyst Eng* is the top ranked comprehensive agricultural engineering journal (number 4 in Table 5) and is one of the five journals published by Elsevier B.V. (Table 1). In general, the JIF and other metrics shown in Table 5 underscore that *Biosyst Eng* is a very important journal within the AE research domain which is further confirmed by global citation trends discussed in Section 3.2.

T ASABE is the second highest ranked comprehensive AE journal in terms of JIF value (0.975) and resides at the bottom of the upper tier of journals (Table 5). However, *T ASABE* attracts a relatively high annual rate of citations (8412 in 2016; Table 5) due in large part to a subset of very highly cited articles[74-84]. The JIF values for *Int J Agr Biol Eng*, *Rev Bras Eng Agr Amb*, *Appl Eng Agric* and *Eng Agr-Jaboticabal* are 0.835, 0.608, 0.505 and 0.353, with *AMA-Agr Mech Asia Af* anchoring the bottom of Table 5 (JIF = 0.118). *Int J Agr Biol Eng* started in 2008 with a quarterly publication cycle and increased to a bimonthly publication rate in 2014, reflecting an increasing number of submissions and gradually strengthening role in the international research community. *Rev Bras Eng Agr Amb* and *Eng Agr-Jaboticabal* are primarily regional journals at present, as reflected by the fact that the vast majority of articles that have been published in both journals to date were written by Brazilian authors (see Section 3.2). However, the conversions to manuscripts written in English for both journals may result in increasing international submissions in the future. *Appl Eng Agric* could be considered a niche journal designed by ASABE to complement *T ASABE* with more applied focused articles, although the distinctions in article types between the two journals are not always clear. *AMA-Agr Mech Asia Af* is clearly a very narrow niche journal focused almost exclusively on agricultural machinery research in developing nation contexts, resulting in a relatively low publication rate and very low citation metrics.

Paddy Water Environ is the other journal listed in the bottom half of Table 5, which is published by Springer Verlag (Table 1) and received a JIF value of 0.916 in 2016. The relatively low JIF value for *Paddy Water Environ*, which is classified as a specialty journal (Tables 1 and 5), suggests that the respective range of published research topics are quite narrow (in spite of the enormous levels of rice production that occur worldwide). However, there could be other factors affecting the exposure and citation rates to articles published in *Paddy Water Environ* including journal

management and overall exposure of the journal among the wider scientific community.

2.3 Long-term JIF trends for JCR AE category journals

Figure 1 shows long-term JIF trends for the 13 journals included in the JCR AE category starting at the year 2000. The plotted JIFs for some of the journals span shorter time periods due to initial indexing of those journals in the JCR in more recent years; e.g., *Int J Agr Biol Eng* in 2015. The *Biosyst Eng* JIF was reported for the first time in 2003 and was previously reported in the JCR using the original *J Agr Eng Res* name (JIF values were reported for both *Biosyst Eng* and *J Agr Eng Res* in the 2003 JCR). Minor name changes also occurred for *T ASABE* in 2006 (previously *T ASAE* through 2005) and *J Irrig Drain Eng* in 2013 (previously *J Irrig Drain Eng ASCE* through 2012).

The initial JIF values for all of the JCR Agricultural Engineering category journals shown in Figure 1 were less than 1.0 and some were less than 0.5. Relatively strong increasing trends in JIF values can be seen for several of the journals although there is also considerable year-to-year variability, reflecting annual shifts in the number of published articles, total citations to a journal's articles, etc. The JIF values for *Bioresource Technol* and *Biomass Bioenerg* have increased by factors of 6 to 8 from the initial year of 2000 to 2016 (Figure 1). Relatively strong trends in increasing JIF values are also shown for *Ind Crop Prod*, *Biosyst Eng* (*J Agr Eng Res*) and *Aquacult Eng*, which increased by respective factors of roughly 2.5 to 4.5 times between 2000 and 2016. A range of long-term JIF trends are reflected in plots of JIF values for the other journals (Figure 1).

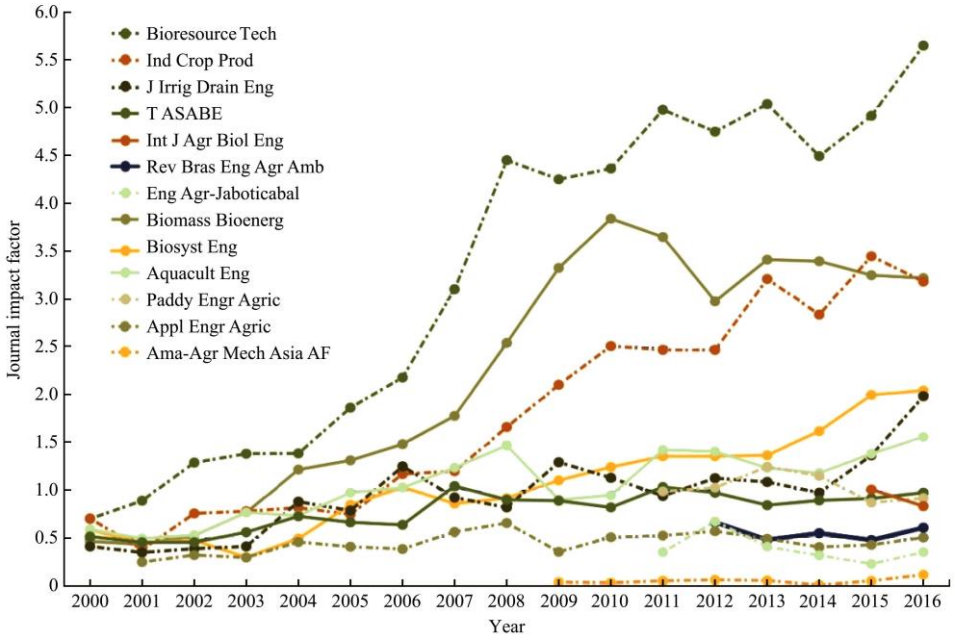

Figure 1 Long-term trends in JIF values for the 13 journals indexed in the JCR Agricultural Engineering category[54]

The general strong increasing JIF value trends shown for *Bioresource Technol* and *Biomass Bioenerg* (Figure 1) confirm the rapid rising research focus on bioenergy related topics that has occurred worldwide in the past decade. However, the annual JIF values for *Biomass Bioenerg* have declined by about 0.6 by 2016, from the peak of roughly 3.8 in 2010, for reasons that are not immediately clear. The JIF values for *Ind Crop Prod* have generally progressively increased from 2000 to 2016, which point to growing interest in the types of industrial crop related topics covered by the journal. The JIF values for *Biosyst Eng* are the only ones among the comprehensive AE journals that display a gradual upward trend over the past decade. In contrast, the JIF values for *T ASABE* and *Appl Eng Agric* have essentially remained static during the decadal period between 2007 and 2016 (Figure 1).

3 Global Research Characteristics of the WoS CC AE category

Members of agricultural engineering societies, university departments focused on agricultural, biological and/or biosystems engineering, and other scientists who are affiliated with those fields in various ways publish research in a broad range of scientific journals that encompasses far more journals than just those indexed in the JCR and WoS CC AE categories. For example, scientists associated with the Iowa State University Agricultural and Biosystems Engineering Department published over 200 articles in WoS CC indexed journals during 2014 to 2016, of which only 22% were published among the 13 AE journals (Helmers M. Personal communication. Agricultural and Biosystems Engineering Dept., Iowa State Univ., 2017). Thus the publication trends associated with the JCR and WoS CC AE category journals can only provide a partial view of the overall publication trends occurring within the AE realm. And a subset of the authors publishing in the 13 journals represent other disciplines that are not directly affiliated with the AE field and related disciplines. However, these trends do provide important insights regarding publication developments occurring among the specialty and comprehensive JCR and WoS CC AE category journals. The results reported in Section 3 were obtained from the journal data indexed in the WoS CC AE category.

3.1 Total articles

Figure 2 shows the trends in total articles published among the journals indexed in the WoS CC AE category during 2006 to 2016 using two different search methods available in the Advanced Search options: (1) Web of Science Category (WC), and (2) Publication Names (SO). The WC method returns all of the articles indexed in the CC AE category for each journal in a given year. The SO option also returns the total articles indexed for selected journals in a specific year, which requires including the

name of each journal in the SO search for the given search year. The two methods result in different totals for some years due to various issues, some of which are described in more detail in Appendix D.

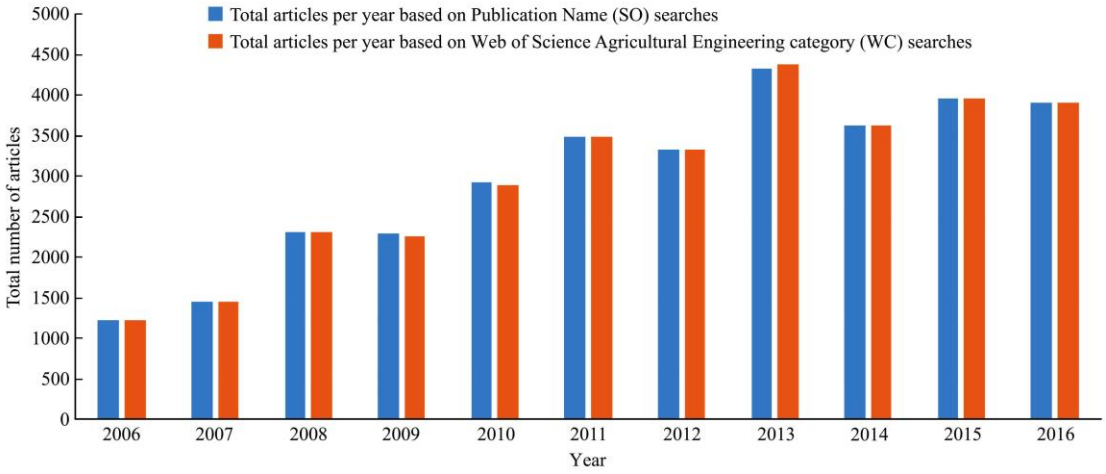

Figure 2 Total articles indexed in the WoS Core Collection Agricultural Engineering category using two different types of search structures as described in Appendix D

The total articles published in the WoS CC AE category journals (Figure 2) generally increased between 2006 and 2013, followed by a slight decline during the next three years. The exact fluctuations during those time periods based on the SO/WC searches were 1222/1225 to 4331/4389 articles from 2006 to 2013, which then declined to 3914/3914 articles in 2016. The general increase in total articles published in the category over the 11-year time period was due in part to additional journals that were indexed in the WoS CC AE category in 2007 or later, although this was offset some by journals that were dropped from the category after being indexed for one to four years. However, large increases in the number of articles published in *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod* during the 11-year period was by far the greatest factor in the overall trend of increased articles. The number of articles published in *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod* increased from respective low total articles of 337 (2006), 95 (2007) and 78 (2007) to respective high total articles of 1987 (2013), 570 (2011) and 937 (2015). In general, only minor shifts in total published articles occurred for the other JCR AE journals during the 11-year period. However, exceptions occurred for the *J Irrig Drain Eng*, *Eng Agr-Jaboticabal* and the *Int J Agr Biol Eng*, which increased from 105 (2006) to 176 (2016), 77 (2008) to 125 (2016) and 50 (2013) to 133 (2016) total articles, respectively.

3.2 Country and regional influences

Table 6 shows the top 20 countries represented by the authors who published studies in journals that were indexed in the WoS CC AE category in 2006 versus 2016. In 2006, authors affiliated with United States institutions contributed over 37% of the articles that were published in the WoS CC AE category, which was equivalent to the next six countries (India, Canada, Spain, Peoples R China, Japan and Turkey) combined. However, dramatic shifts occurred in the contributing countries by 2016, with authors located in the Peoples R China contributing over articles 28% of the overall articles. This was roughly equal to the total articles contributed by the combined authors from the United States and Brazil in 2016 (Table 6), which were ranked second and third, respectively. The surge in published articles by Chinese authors in the WoS CC AE category mirrors similar increasing publication trends by Chinese institutions in other scientific disciplines[86-92]. In general, articles contributed by authors located in the countries listed in Table 6 for 2006 greatly increased by 2016, although the order of ranking shifted considerably over that ten-year time period. Of particular note was the increase in published articles from Brazilian authors, which was likely primarily due to the indexing of the two Brazilian journals to the WoS CC and the JCR (Table 1) between 2006 and 2016.

Further investigation of contributing authors by country was conducted for all of the comprehensive agricultural engineering journals listed in Table 1, except for *AMA-Arg Mech Asia Af* due to the more narrow topical focus of that journal as previously discussed. Figure 3 shows the distribution of author affiliations of the top 25 countries or regions who published in *Biosyst Eng* during 2002 to 2016, which has manifested the strongest JIF trends among the comprehensive agricultural engineering journals during the past decade (Figure 1). Authors from the United States were the top contributors to *Biosyst Eng* during the 2002 to 2016, having written slightly over 14% of the studies published during that time period. The percentage contributions of the next 10 ranked countries/regions ranged from 8.8% (Spain) to 4.4% (the Netherlands), with a gradual decline in percentage contributions from the remaining 14 countries. However, the total articles contributed from European countries account for 54% when European authors are viewed as a combined contributing block. In general, the data in Figure 3 reveals that the locations of authors who contribute to *Biosyst Eng* are distributed across a wide range of countries and regions, indicating that the journal has established a strong worldwide influence.

The distribution of country/region authorship shows a distinctly different pattern for the other five comprehensive AE journals, all of which are dominated by articles contributed from the host country that the journal is published in (Table 7). The concentration of authorship represented by the respective host country ranged from 71.6% (China) for *Int J Agr Biol Eng* to 99.1% (Brazil) for *Rev Bras Eng Agr Amb* during 2002 to 2016. The concentration patterns remained virtually identical through roughly the first one-third of 2018, except for an increasing concentration of authors from China for *Int J Agr Biol Eng* (Table 7). These concentration trends underscore that the five journals listed in Table 7 tend to serve more as specific regional publication outlets as compared to *Biosyst Eng*, especially for the two journals that are published in Brazil. However, these publication

characteristics do not necessarily reflect overall global influence as discussed in further detail in Section 3.3, especially regarding highly cited articles published in *T ASABE*.

Table 6 Top 20 countries/regions with authors who published studies in the 2006 and 2016 WoS CC AE Category

2006				2016			
Rank	Countries/Regions	Amount	Proportion/%	Rank	Countries/Regions	Amount	Proportion/%
1	United States	457	37.4	1	Peoples R China	1132	28.1
2	India	160	13.0	2	United States	669	16.5
3	Canada	77	6.3	3	Brazil	474	11.8
4	Spain	75	6.1	4	India	300	7.5
5	Peoples R China	70	5.7	5	South Korea	225	6.3
6	Japan	46	3.8	6	Spain	176	4.4
7	Turkey	42	3.4	7	Italy	171	4.2
8	Sweden	31	2.5	8	Canada	146	3.6
9	Italy	30	2.5	9	France	126	3.1
10	Australia	27	2.2	10	Germany	120	3.0
11	England	25	2.0	11	Iran	107	2.7
12	South Korea	24	2.0	12	Australia	101	2.5
13	Brazil	21	1.7	13	Japan	94	2.3
14	France	20	1.6	14	England	73	1.8
15	Taiwan	20	1.6	15	Portugal	67	1.7
16	Belgium	19	1.6	16	Netherlands	62	1.5
17	Iran	19	1.6	17	Turkey	60	1.5
18	Netherlands	19	1.5	18	Taiwan	56	1.4
19	Germany	18	1.4	19	Malaysia	53	1.3
20	Denmark/Thailand[a]	17	1.4	20	Belgium	51	1.3

Note: [a] Denmark and Thailand were tied for the number 20 rank in 2006 with 17 articles each.

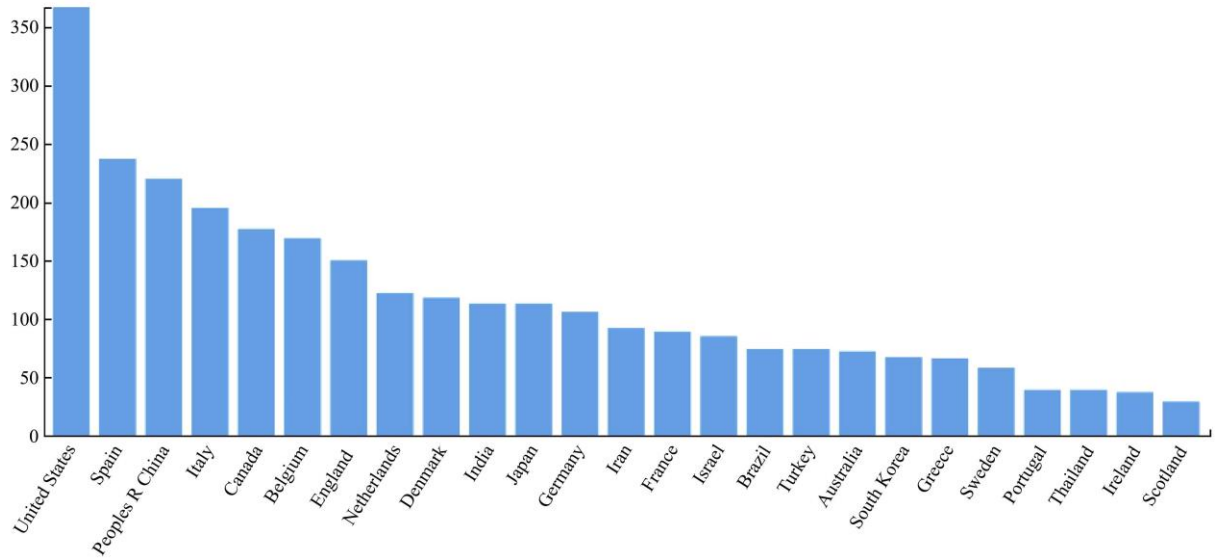

Figure 3 Distribution of countries represented in articles that were published in *Biosystems Engineering* during 2002 to 2016 as reported in the WoS CC AE category

Table 7 Concentration of authorship from the host country, where the respective journal is published in, for five of the comprehensive agricultural engineering journals

Journal	2002 to 2016		2002 to 2018[a]	
	Country	%	Country	%
Appl Eng Agric	United States	76.0	United States	75.0
Eng Agr-Jaboticabal	Brazil	96.6	Brazil	96.7
Int J Agr Biol Eng	China	71.6	China	77.9
Rev Bras Eng Agr Amb	Brazil	99.1	Brazil	99.0
T ASABE	United States	76.1	United States	75.8

Note: [a] As reported in the WoS CC through May 16, 2018.

Table 8 lists the top 20 contributing organizations/institutions regarding articles published in the Wos CC AE category in 2006 and 2016. The contribution patterns exhibited in Table 8 are reflective of the countries/region rankings in Table 6, as shown by the dominance of U.S. agencies and universities in 2006 versus increased influence of counterpart Chinese and Brazilian research organizations in 2016. Several Indian institutes and universities were also represented in both 2006 and 2016.

Table 8 Top 20 organization/institution affiliations of authors who published studies in the 2006 and 2016 WoS CC AE Category[a]

2006				2016			
Rank	Organization/Institution	Amount	Proportion%	Rank	Organization/Institution	Amount	Proportion%
1	United States Dept. of Agric.	158	14.0	1	Chinese Acad. of Sciences	140	3.5
2	State Univ. System of Florida	32	2.8	2	United States Dept. of Agric.	115	2.9
3	Indian Inst. of Technology	31	2.7	3	Council Sci. Ind. Res. CSIR India	82	2.0
3	Univ. of Florida	31	2.7	4	Harbin Inst. of Technology	63	1.6
5	Council Sci. Ind. Res. CSIR India	25	2.2	5	Universidade Estadual Paulista	61	1.5
5	Texas A&M Univ. System	25	2.2	6	China Agric. Univ.	59	1.5
7	Univ. of California System	22	1.9	6	Univ. Chinese Academy of Sciences	59	1.5
7	Kansas State Univ.	21	1.9	8	Zhejiang Univ.	58	1.4
9	Texas A&M Univ. College Station	20	1.8	9	Universidade De Sao Paulo	46	1.1
10	Univ. of California Davis	18	1.6	9	Univ. of Tehran	46	1.1
11	United States Forest Service	17	1.5	11	Universidade Federal De Vicosa	45	1.1
11	Indian Council of Agric. Res.	16	1.4	12	Indian Inst. of Technology	44	1.1
11	Univ. of Illinois System	16	1.4	12	Univ. of Science Technology	44	1.1
11	Univ. of Illinois Urbana Champaign	16	1.4	14	Univ. of California System	40	1.0
11	Univ. of Nebraska System	16	1.4	15	Embrapa[#]	39	1.0
11	Univ. System of Georgia	16	1.4	15	South China Univ. of Technology	39	1.0
11	Wageningen Univ. Res.	16	1.4	17	Northwest A F Univ. China	37	0.9
18	Iowa State Univ.	15	1.3	17	Washington State Univ.	37	0.9
18	Penn State Univ.	15	1.3	18	Indian Council of Agric. Res.	35	0.9
18	Pennsylvania Comm. SHE	15	1.3	18	Univ. of Technology Sydney	35	0.9
18	University of Nebraska	15	1.3				

Note: [a] Duplicate rank numbers reflect ties in reported amount of publications between institutions in 2006 or 2016.
[#] The full name for Embrapa that is reported in the WoS Core Collection search is Empresa Brasileira de Pesquisa Agropecuaria.

3.3 Characteristics of top cited articles

A final assessment of the WoS CC AE category was performed by determining the distribution of topics among the all-time top 50 cited articles for the complete AE category (Table 9) and then for the journals defined as comprehensive AE journals (Table 10). The search structures used for determining the top 50 articles for each table (Appendix A) were constructed so that all of the articles that have been indexed for each of the journals in the WoS CC were included. This required including *T ASAE* and *J Agr Eng Res*, the original names for *T ASABE* and *Biosyst Eng*, in the search structures to ensure that all of the older articles that were published in those two journals were considered within the analysis. A total of 58 750 and 23 086 articles were returned for the searches used to construct Tables 9 and 10, respectively.

The citations for the all-time top cited 50 articles for the 13 journals (Table 9) in the entire AE category ranged from 2980 for Mosier et al. (2005)[93] to 537 for Allen et al.[94] Studies published in *Bioresource Technol* were by far the most dominant, accounting for 34 of the overall top 50 cited articles. The remaining 16 studies were almost evenly split between *Biomass Bioenerg* and *T ASABE/T ASAE*, with one article published in *J Irrig Drain Eng*. Nine of the top 10 cited articles, ranging between the 2980 citations for Mosier et al.[93] and 1572 citations for Alvira et al.[95], were published in *Bioresource Technol*. The only exception was Moriasi et al.[82], which was published in *T ASABE* and cited 2695 times. In general, bioenergy related topics were the dominant themes of the top cited articles although some exceptions occurred, especially for the top cited articles published in *T ASABE/T ASAE*.

Table 9 Summary of the all-time top 50 cited journal articles that are indexed in the Web of Science Core Collection Agricultural Engineering category[a]

Journal	General topic[b]	Total articles
Bioresource Technol	Anaerobic digestion processes	2
	Biodiesel production processes	7
	Chemical or microbial processes	7
	Other biofuel production processes	4
	Processing of lignocellulosic biomass	5
	Technologies for remediation of dye wastes and other processes	7
	Vegetation and/or other biofuel source material	2
Biomass Bioenerg	Other biofuel production processes	1
	Processing of lignocellulosic biomass	1
	Technologies for remediation of dye wastes and other processes	1
	Vegetation and/or other biofuel source material	5
T ASABE/ T ASAE	Biodiesel production processes	1
	Soil properties	1
	Water quality, erosion or related environmental modeling	5
J Irrig Drain Eng	Evapotranspiration analysis	1

Note: [a] The distribution of the top 50 cited articles shown here is based on search (Appendix A) results that were obtained on June 3, 2018 for 58,750 articles indexed in the WoS CC AE category for the 13 journals listed in Table 1.
[b] The topics represent subjective groupings based on information in the article titles, abstracts and/or text.

The citations for the subset of top cited comprehensive AE journal articles (Table 10) ranged from 2695[82] to 175[96]. Articles published in *T ASABE/T ASAE* dominated the distribution of top cited articles for the seven comprehensive AE journals and accounted for 14 of the top 15 cited articles, ranging from the top cited Moriasi et al.[82] to 311 citations for Buffington et al.[97] The lone exception among the top 15 cited articles was Thompson et al.[98], which was published in *Appl Eng Agric* and accrued 333 citations at the time the search was performed. The remaining top cited articles were all published in *Biosyst Eng*/*J Agr Eng Res* (Table 10).

Table 10 Summary of the all-time top 50 cited comprehensive agricultural engineering journal articles that are indexed in the Web of Science Core Collection Agricultural Engineering category[a]

Journal	General topic[b]	Total articles
T ASABE /T ASAE	Biodiesel production processes	5
	Food processing or properties	2
	Irrigation or other water resource management issues	1
	Livestock housing conditions	1
	Measurement methods for agricultural materials	6
	Monitoring of soil erosion or in-stream pollutants	2
	Other biofuel production processes	4
	Soil conservation practices	2
	Soil properties	2
	Water quality, erosion or related environmental modeling	13
Biosyst Eng /J Agr Eng Res	Food processing or properties	3
	Livestock environmental issues	2
	Livestock housing conditions	2
	Measurement methods for agricultural materials	1
	Remote sensing analysis	1
	Soil properties	2
	Irrigation or other water resource management issues	1
Appl Eng Agric	Biodiesel production processes	1

Note: [a] The distribution of the top 50 cited articles shown here is based on search (Appendix A) results that were obtained on June 3, 2018 for 58,750 articles indexed in the WoS CC AE category for the 13 journals listed in Table 1.
[b]The topics represent subjective groupings based on information in the article titles, abstracts and/or text.

A considerably different distribution of topics emerges for the all-time top 50 cited articles that were determined for the seven comprehensive AE journals (Table 10), as compared to the distribution in Table 9. Dominant themes include water quality modeling and other environmentally related topics, water resource management and measurement methods. Biofuel related topics are an important subcategory but are clearly not dominant among the overall distribution of topics (Table 10). The striking differences between the Table 9 and 10 topical distributions provide further insight into the extensive differences in published content that characterize the comprehensive AE journals versus the specialty journals (Table 1). The Table 10 results also underscore that *T ASABE/T ASAE* has obtained a level of influence within the scientific community that exceeds initial impressions based on just the JIF (Table 5), at least for a smaller set of several dozen highly cited studies.

4 Reflections on the Need for Revised JCR AE and WoS CC AE Journal Categories

A "white paper" published by Thomson Reuters (2014)[99] includes discussion regarding the importance of correctly evaluating and interpreting citation data, including the metrics reported in the JCR. The white paper further explicitly states: "*The importance of interpreting and understanding these data correctly cannot be emphasized too strongly. Using quantitative citation data to measure impact is meaningful only in the context of journals in the same general discipline. For example, smaller fields like Agricultural Engineering do not generate as many articles or citations as larger fields like Biotechnology or Genetics*." The authors of the white paper correctly identify the fact that the field of agricultural engineering is relatively small, as evidenced by the trends in total articles and citations reported above. And the authors also accurately note the need to compare metrics between journals within the context of specific disciplines, rather than trying to compare across disciplines that differ greatly in topical content, total articles published and rate of citations. However, the current mix of journals included in the JCR AE and WoS CC AE categories ironically contradicts the quote stated above, by literally comparing comprehensive AE journals versus biotechnology-related journals (see Tables 1 to 4).

4.1 Structural and topical problems related to the specialty journals

The problems related to including specialty journals in the JCR AE and WoS CC AE journal categories are most apparent regarding *Bioresource Technol*, *Ind Crop Prod* and *Biomass Bioenerg*, due to: (1) reporting of topical coverage that is very narrow relative to comprehensive AE journals (Table 3); (2) publication of considerably higher numbers of articles on average (e.g., Table 2); and (3) corresponding accrual of much higher rates of citations (Table 5 and Figure 1). In addition, *Bioresource Technol* and *Biomass Bioenerg* are both categorized in the JCR Biotechnology & Applied Microbiology category (as well as the JCR Energy & Fuels category), which is inconsistent with the position taken in Thomsen Reuters (2014)[99] white paper as noted above. Overall, these characteristics further confirm that the scientific communities that publish in these three specialty journals are very large and considerably different, relative to the counterpart communities that publish in the comprehensive AE journals (as also discussed in Section 2.1).

The publication, citation and metric characteristics for the *J Irrig Drain Eng*, *Paddy Water Environ* and *Aquacult Eng* are more consistent with the corresponding characteristics of the comprehensive AE journals (Tables 2 and 5; Figure 1). However, these three journals are also structurally very different from the comprehensive AE journals (see again Tables 3 and 4). The *J Irrig Drain Eng* focuses primarily on drainage and irrigation issues (Table 4) and is one of 38 journals published by the American Society of Civil Engineering (ASCE, 2018), which reflects the enormous size of the society relative to ASABE, EurAgEng and other agricultural engineering societies. The *J Irrig Drain Eng* is one of several water resource related journals published by ASCE (others include the *J Hydraul Eng*, *J Hydrol Eng* and *J Water Resour Plan*), all of which are potentially relevant to smaller subsets of the AE scientific community and are sometimes cited by authors publishing in comprehensive AE journals (or vice versa). *Paddy Water Environ* is defined on the journal website[57] in the context of agricultural engineering but is specifically focused on

rice paddy systems (Table 4), which is a minor research theme among the comprehensive AE journals. Similarly, *Aquacult Eng* publishes research that is focused solely on aspects of aquaculture production, a topic that is of very limited interest within the broader scientific communities that publish in comprehensive AE journals.

4.2 Citation pattern issues between the comprehensive AE journals and specialty journals

A final aspect to consider is citation patterns between the comprehensive AE journals and the specialty journals currently indexed the JCR AE and WoS CC AE categories, as well as other relevant journals. Relevant citation relationships were investigated using the 2017 JCR "Cited Journal Data", which list citations from articles in other journals to articles in the journal of interest[101], and "Citing Journal Data", which list citations from articles in the journal of interest to articles in other journals[102]. These two types of citation data are described in more detail in Appendix E. The specific citation data for the journals of interest are reported in Tables E.2 and E.3 and reflect aggregate citations between the reference journal and other specific journals of interest that have been accrued for over a decade. The focus of the citation pattern assessment is on the citation relationships between the *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*, based on overall international influence (Figure 1 and Table 7) among the seven comprehensive AE juornals, and other relevant journals. Note that the number of citations listed for a specific journal in Tables E.2 and E.3 should be viewed in the context of the overall total citations listed at the top of each data column for a given journal.

Selected Cited Journal Data and Citing Journal Data are reported for *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod* (Table E.2), both in the context of inter-citation relationships between those three journals and versus *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*. These citation data reflect relatively strong inter-citation patterns between *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod*, especially between *Bioresource Technol* and *Biomass Bioenerg*. In contrast, the two types of citation data reveal relatively weak citation relationships between the three specialty journals and the four comprehensive AE journals. This is due in part to the magnitude of citations that the two subsets of journals typically receive. But the primary reason is the fact that the overall spectrum of topic ranges between the two subsets of journals do not extensively overlap.

Table E.3 features selected Cited Journal Data and Citing Journal Data for *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*, in the context of the other journals listed in Table 1 and eight other journals (Table E.1) that are characterized by relatively strong citation relationships with one or more of the four comprehensive AE journals. The four comprehensive AE journals tend to cluster near the top of each column in Table D.3, revealing overall strong citation patterns between those four journals. However, the *Int J Agr Biol Eng* has so far drawn only limited citations from articles published in *Appl Eng Agric*, *Biosyst Eng* and *T ASABE* (i.e., the *Int J Agr Biol Eng* cited data column in Table E.3) and in general has manifested weaker citation relationships with the other three journals to date. Notable citation patterns are shown across most of the Table E.3 data columns between the four comprehensive AE journals and *Bioresource Technol*, *Biomass Bioenerg* and *J Irrig Drain Eng*. However, a qualitative evaluation of the citation data in Table E.3 suggests that there are multiple journals listed in Table E.1 (i.e., *Comput Electron Agr*, *Agr Water Manage*, *J Food Eng*, *J Environ Qual*) that are characterized by citation relationships with the four comprehensive AE journals that are as strong or stronger than the citation relationships demonstrated with *Bioresource Technol*, *Biomass Bioenerg* and *J Irrig Drain Eng*. Generally weak signals occur in terms of citations between the four comprehensive AE journals and *Ind Crop Prod*, *Paddy Water Environ* and *Aquacult Eng*, underscoring the overall lack of relationship between these three specialty journals and *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*.

Overall, the citation data presented in Tables E.2 and E.3 further confirm that there is no practical reason to include any of the six specialty journals (Tables 1 and 4) in the JCR AE and WoS CC AE journal categories. The citation data in Table E.3 also provide a glimpse of the broad sub-disciplines that intersect with comprehensive AE journals. For example, the strongest relationship across the four comprehensive AE journals was with *Comput Electron Agr* (Table E.3), which publishes computer-related research for a variety of agricultural and related subdisciplines including agronomy, horticulture, forestry, aquaculture, livestock production and food processing[103]. There is also a very discernible relationship between the four comprehensive AE journals and journals categorized as environmental science, ecology, soil science and/or water resource journals (Table E.1). This is consistent with the findings of Leydesdorff and Rafols (2009)[104] who mapped the JCR AE category to a broader Environmental Sciences group that included Environmental Sciences and Water Resources among other JCR categories. A qualitative assessment of *T ASABE* Cited Journal Data and Citing Journal Data reveals particularly strong relationships with journals indexed in the JCR Environmental Sciences and Water Resource categories. In addition, four *T ASABE*/*T ASAE* water quality or soil property related articles[74,77,82,83] would be ranked in the top 100 all-time most cited articles in the WoS Water Resources category, of over 278 000 articles currently indexed in that category, if the journal was also indexed in the JCR Water Resources category (search structure reported in Appendix A).

4.3 Establishing more accurate JCR AE and WoS CC AE journal categories

The specialty journals currently included in the JCR AE and WoS CC AE journal categories are all relevant to smaller subsets of scientists who identify as members of the agricultural engineering community and/or publish in comprehensive AE journals. However, that fact does not warrant inclusion of those specialty journals in the JCR AE and WoS CC AE categories. And as previously discussed, there are other specialty journals that are potentially just as or more relevant in the relational sphere that the comprehensive AE journals exist in. More importantly, the inherent differences between the comprehensive AE journals (Table 3) versus the specialty journals (Table 4) undermine the grouping of the two subsets of journals in the same JCR AE and WoS CC AE journal categories.

Comparison of JCR reported metrics between specific specialty journals versus comprehensive AE journals can be of logical interest to scientists who are seeking the most desirable outlet for publishing bioenergy related research or other research of potential interest to a specific journal. However, direct comparisons of such metrics to evaluate overall journal content within the context of the current JCR AE category should be avoided, due to the extensive differences between the two subsets of journals. Comprehensive AE journals should instead be compared directly

only between each other. And the overall evaluation conducted here points to the need for revised JCR AE and WoS CC AE journal categories that include just comprehensive AE journals.

One potential problem with creating a specific comprehensive AE journals JCR category is the relatively small sample size of the subset of journals, which would consist of a total of only seven journals (Table 1) at present. This would likely result in statistical problems per the establishment of journal quartile rankings and other analyses for the specific category. However, this would eliminate the current distortion of the majority of comprehensive AE journals being ranked in the third (Q3) or fourth (Q4) quartiles, due to the inconsistent comparisons versus the specialty journals. In addition, this category could include comprehensive AE journals that are currently indexed in the Core Collection in the future. For example, the Journal of Agricultural Engineering[105] and INMATEH – Agricultural Engineering[106] are currently indexed in the WoS CC ESCI database and may ultimately be indexed in the WoS CC SCIE database and JCR database. And as noted previously, there are a number of other comprehensive AE journals that may warrant consideration for inclusion in the WoS CC in the future, such as *Canadian Biosystems Engineering*[34], *Agricultural Engineering International: CIGR Journal*[35] and *Research in Agricultural Engineering*[107].

5 Conclusions and recommendations

The review of the JCR AE and WoS CC AE journal categories reveals dichotomies per the journals currently indexed as AE journals. *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod* are unquestionably the dominant journals in terms of the JIF and other journal metrics. However, those three journals are also characterized by radically different topical content, publication rates and citation accruals relative to the comprehensive AE journals, indicating that direct comparisons between the two subsets of journals are not realistic. Incongruent overall topical content also undermines any rational basis for direct comparisons between *J Irrig Drain Eng*, *Paddy Water Environ* and *Aquacult Eng* and the comprehensive AE journals, in spite of similar publication and citation rates.

Biosyst Eng has emerged as the premier journal among the comprehensive AE journals, when those journals are evaluated on the basis of the JIF and 5-year JIF. However, *T ASABE* consistently draws more total citations and is further characterized by more very highly cited studies, which underscores that journals should be evaluated by a variety of metrics; the latter point is an aspect of journal evaluation that is strongly stressed by Clarivate Analytics[108]. *Biosyst Eng* also draws citations from a much broader cross section of individual countries than the other comprehensive AE journals, indicating that the journal has established a stronger overall global presence at present relative to the similar journals evaluated here.

Publication trends evaluated in this study show that the total number of articles that are published annually in the JCR AE and WoS CC AE journal categories increased by roughly a factor of 3 during the time period of 2006 to 2016. However, the primary reason for this increase was due to large increases in the number of articles published in *Bioresource Technol*, *Biomass Bioenerg* and *Ind Crop Prod* over that time period. The publication trends also revealed that Chinese scientists are publishing articles at an increasingly higher rate in the 13 AE journals and that Chinese institutions have become the dominant contributors to JCR AE and WoS CC AE journal categories. However, it is important to recognize that members of AE department faculties and scientists in related fields regularly publish in journals indexed in Water Resource, Environmental Science and other JCR categories, and that scientists in unrelated fields publish at times in the AE-indexed journals.

Some specific recommendations are also offered regarding the current to JCR AE and WoS CC AE journal categories:

1) Scientists and others who are interested in performing in-depth evaluations of different comprehensive AE journals, based on journal metrics and other factors, should limit those assessments to the subset of comprehensive AE journals (Table 1) that are indexed in the JCR AE and WoS CC AE journal categories.

2) Direct comparisons between comprehensive AE journals and specialty journals can be a rational approach when individual researchers and research teams are interested in determining desirable publication outlets for biofuel, water quality, aquaculture or any other specific type of studies. However, it should be kept in mind that comprehensive AE journals will typically have lower JIF values and other journal metrics, relative to competing specialty journals, due to the lower accrual of citations that occurs for comprehensive AE journals (which is further exacerbated by smaller subsdisciplines that routinely publish in comprehensive AE journals).

3) The review conducted here points to the need for revised JCR AE and WoS CC AE journal categories that consist solely of comprehensive AE journals. It is possible that a secondary category could be developed that includes relatively strongly related specialty journals, but those mix of journals would be considerably different as compared to the current distribution of journals in the JCR AE and WoS CC AE categories.

[References]

[1] Mays L W. A brief history of water technology during antiquity: Before the Romans. In: Mays L W (Ed.). Ancient Water Technologies. Heidelberg, Germany: Springer Dordrecht, 2010; pp.1–28.

[2] Tamburrino A. Water technology in ancient Mseopotamia. In: Mays L W (Ed.). Ancient Water Technologies. Heidelberg, Germany: Springer Dordrecht, 2010; pp.29–51.

[3] Mays L W, Gorokhovich Y. Water technology in the ancient American societies. In: Mays L W (Ed.). Ancient Water Technologies. Heidelberg, Germany: Springer Dordrecht, 2010; pp.171–200.

[4] Bizzarri C, Soren D. Etruscan domestic architecture, hydraulic engineering, and water management technologies innovations and legacy to Rome. In: Bell S, Carpino A A (Ed.). A Companion to the Etruscans. New York, NY. John Wiley & Sons, Inc. 2015; pp.129–145. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118354933. Accessed on [2018-02-22].

[5] Mays L W. A brief history of Roman water technology. In: Mays L W (Ed.). Ancient Water Technologies. Heidelberg, Germany: Springer Dordrecht, 2010; pp.115–137.

[6] Leigh D S, Kowalewski S A, Holdridge G. 3400 years of agricultural engineering in Mesoamerica: lama-bordos of the Mixteca Alta, Oaxaca, Mexico. Journal of Archaeological Science, 2013; 40: 4107–4111. doi: 10.1016/j.jas.2013.05.009.

[7] ASABE. Part 2. Timeline in the development of agricultural field Implements, related apparatus, and equipment. St. Joseph, MI: American Society of Agricultural and Biological Engineers. 2018. https://www.asabe.org/media/129817/timelinespart2.pdf. Accessed on [2018-02-22].

[8] Smith G S. McCormick, Cyrus Hall: (15 February 1809–13 May 1884). Oxford, United Kingdom: Oxford University Press, 2018. http://www.anb.org/view/10.1093/anb/9780198606697.001.0001/anb-9780198606697-e-1001098. Accessed on [2018-02-22].

[9] Ricci T. Jethro Tull: Biography. New York, NY: American Society of Mechanical Engineers. https://www.asme.org/engineering-topics/articles/history-of-mechanical-engineering/jethro-tull. Accessed on [2018-02-22].

[10] Mirsky J, Nevins A. The World of Eli Whitney. Science and Society, 1953; 17(3): 282–284.
[11] Herrmann K. Milestones in the history of agricultural engineering. Landtechnik, 2011; 66(4): 297–299. doi: 10.15150/lt.2011.415.
[12] AEA. The Agricultural Engineers Association: The voice of the agricultural, environmental and amenity machinery sectors. Hampton, Peterborough, United Kingdom. 2012. http://www.aea.uk.com/. Accessed on [2018-03-24].
[13] ASABE. ASABE – 100 years of innovation: Engineering for a sustainable future. St. Joseph, MI: American Society of Agricultural and Biological Engineers. 2018. https://www.asabe.org/about-us/history.aspx. Accessed on [2018-02-22].
[14] DBBE. The first century forward: Bioproducts and Biosystems Engineering at the University of Minnesota 1909-2009. Department of Bioproducts and Biosystems Engineering, Institute of Technology, University of Minnesota. https://bbe.umn.edu/sites/bbe.umn.edu/files/BBEs%20Rich%20History.pdf. Accessed on [2018-03-20].
[15] TAMU. Department of Biological and Agricultural Engineering. Texas A&M University, College Station, Texas. 2018. https://baen.tamu.edu/about/history/. Accessed on [2018-03-19].
[16] Bateman H P, Foster W A, Jones, Jr. B A, Lembke W D. Agricultural Engineering on the Prairie: Illinois Style: A history of the University of Illinois Department of Agricultural Engineering, 1921–1997. Urbana-Champaign, IL: Department of Agricultural Engineering, University of Illinois. 1998. https://abe.illinois.edu/about/history. Accessed on [2018-02-22].
[17] PSU. The History of the Department. Department of Agricultural and Biological Engineering, Pennsylvania State University, University Park, Pennsylvania. 2018. https://abe.psu.edu/about/brief-history-of-department. Accessed on [2018-10-09].
[18] Wrest Park History Contributors. Chapter 1: The early years: 1924–1947. Biosystems Engineering, 2009; 103(Supplement 1): 6–18. doi: 10.1016/j.biosystemseng.2008.11.018.
[19] Wrest Park History Contributors. Chapter 2: The Wrest Park years 1948–2006. Biosystems Engineering, 2009; 103 (Supplement 1): 19-35. doi: 10.1016/j.biosystemseng.2008.11.029.
[20] Hansen E L, McColly H F, Stone A A, Davidson J B. Introducing Agricultural Engineering in China. Agricultural and Biosystems Engineering Technical Reports and White Papers. 14. Ames, IA: Department of Agricultural and Biosystems Engineering. http://lib.dr.iastate.edu/abe_eng_reports/14?utm_source=lib.dr.iastate.edu%2Fabe_eng_reports%2F14&utm_medium=PDF&utm_campaign=PDFCoverPages. Accessed on [2018-03-02].
[21] Dinglai T. Brief history of agricultural engineering development in China: In memory of Mr. Zou Bingwen. International Journal of Agricultural and Biological Engineering, 2008; 1(1): 8–11. doi: 10.3965/j.issn.1934-6344.2008.01.008-011.
[22] Zhou X, Dong R, Li S, Peng G, Zhang L, Hou J, et al. Agricultural Engineering in China. Agricultural Engineering International: CIGR Journal, 2003; 5. http://www.cigrjournal.org/index.php/Ejounral/issue/view/24. Accessed on [2018-03-21].
[23] EurAgEng. European Society for Agricultural Engineers: The European network for engineering and systems in the rural sector. Cranfield, United Kingdom. 2016. https://www.eurageng.eu/. Accessed on [2018-03-24].
[24] CSAE. Chinese Society of Agricultural Engineering. Beijing, China. 2018. http://www.csae.org.cn/ (in Chinese). Accessed on [2018-11-09].
[25] SEAg. Society for Engineering in Agriculture. Faculty of Engineering and Surveying, University of Southern Queensland, Toowoomba, Australia. 2018. https://www.engineersaustralia.org.au/Communities-And-Groups/Technical-Societies/Society-For-Engineering-In-Agriculture. Accessed on [2018-03-19].
[26] CIGR. Member Organizations. International Commission of Agricultural Engineering. University of Florida, Gainesville, Florida, 2018. http://cigr.org/Who-We-Are/member-organizations.php#. Accessed on [2018-03-18].
[27] CIGR. About CIGR: Who We Are. International Commission of Agricultural Engineering. University of Florida, Gainesville, Florida. 2018. http://cigr.org/Who-We-Are/about.php#. Accessed on [2018-03-18].
[28] ASAE. Agricultural Engineering. The Journal of the American Society of Agricultural Engineers. American Society of Agricultural Engineers, St. Joseph, Michigan. 1920. ALMA21193510520002756&context=L&vid=01IASU&lang=en_US&search_scope=ComboPrimocentral&adaptor=Local%20Search%20Engine&tab=default_tab&query=title,exact,Agricultural%20Engineering,AND&sortby=rank&mode=advanced&pfilter=pfilter,exact,journals,AND&offset=0. Accessed on [2018-11-09].
[29] ASABE. Transactions of the ASAE: Vol. 1 No. 1 1958. St. Joseph, MI: American Society of Agricultural and Biological Engineers. 2018. https://elibrary.asabe.org/toc_journals.asp?volume=1&issue=1&conf=t&confalias=t1&orgconf=t1958. Accessed on [2018-09-04].
[30] ASABE. Applied Engineering in Agriculture: Vol. 1 No. 1 1985. St. Joseph, MI: American Society of Agricultural and Biological Engineers. 2018. https://elibrary.asabe.org/toc_journals.asp?volume=1&issue=1&conf=aeaj&confalias=aeaj&orgconf=aeaj1985. Accessed on [2018-09-04].
[31] Elsevier. Biosystems Engineering. Amsterdam. The Netherlands: Elsevier B.V. 2018. https://www.journals.elsevier.com/biosystems-engineering. Accessed on [2018-03-19].
[32] Elsevier. Journal of Agricultural Engineering Research. Amsterdam. The Netherlands: Elsevier B.V. 2018. https://www.sciencedirect.com/journal/journal-of-agricultural-engineering-research. Accessed on [2018-03-19].
[33] CSAE. International Journal of Agricultural and Biological Engineering. Chinese Society of Agricultural Engineering, Beijing, China. 2018. https://www.ijabe.org. Accessed on [2018-03-18].
[34] CSBE. Canadian Biosystems Engineering. Canadian Society for Bioengineering, University of Manitoba, Winnipeg, Manitoba. 2018. https://csbe-scgab.ca/publications/cbe-journal. Accessed on [2018-03-18].
[35] CIGR. Agricultural Engineering International: CIGR Journal. Chinese Academy of Agricultural Mechanization Sciences (CAAMS), Beijing, China. 2018. Accessed on [2018-03-18].
[36] PAGEPress. Journal of Agricultural Engineering. Italian Society of Agricultural Engineering. Pavia, Italy: PAGEPress srl Scientific Publications. https://www.agroengineering.org/index.php/jae/about/journalSponsorship. Accessed on [2018-03-06].
[37] SBEA. Engenharia Agrícola. Brazilian Association of Agricultural Engineering, São Paulo State University, Castellane, São Paulo, Brazil. 2018a. http://www.scielo.br/scielo.php?script=sci_serial&pid=0100-6916&lng=en&nrm=iso. Accessed on [2018-03-26].
[38] Bollen J, Van de Sompel H, Hagberg A, Chute R. A Principal Component Analysis of 39 Scientific Impact Measures. PLoS ONE, 2009; 4(6): e6022. doi: 10.1371/journal.pone.0006022.
[39] Clarivate Analytics. Know your metrics: Immediacy Index. Philadelphis, PA: Clarivate Analytics. 2018. https://clarivate.com/blog/science-research-connect/research-management/know-your-metrics-immediacy-index/. Accessed on [2018-03-26].
[40] Clarivate Analytics. Journal Citation Reports: Quick reference guide. Philadelphis, PA: Clarivate Analytics. 2018. https://clarivate.libguides.com/jcr. Accessed on [2018-03-23].
[41] Harzing A-W. Publish or Perish: Metrics. Anne-Wil Harzing, Middelsex University, London, United Kingdom. 2018. https://harzing.com/resources/publish-or-perish#metrics.
[42] Harzing A-W. Publish or Perish 4 User's Manual: Citation Metrics. Anne-Wil Harzing, Middelsex University, London, United Kingdom. 2016. https://harzing.com/pophelp/metrics.htm.
[43] Elsevier. Research Metrics. Amsterdam, The Netherlands: Elsevier B.V. 2018. https://www.elsevier.com/solutions/scopus/features/metrics. Accessed on [2018-03-19].
[44] Univ. of Michigan. Research impact metrics: citation analysis. Research Guides, University of Michigan Library, Ann Arbor, Michigan. 2018. http://guides.lib.umich.edu/c.php?g=282982&p=3408326. Accessed on [2018-03-23].
[45] Garfield E. Citation indexes for science: A new dimension in documentation through association of ideas. Science, 1955; 122(3159): 108–111. doi: 10.1126/science.122.3159.108.
[46] Garfield E, Sher I H. New factors in the evaluation of scientific literature through citation indexing. Journal of the Association for Information Science and Technology, 1963; 14(3): 195–201. doi: 10.1002/asi.5090140304.
[47] Bensman S J. 2007. Garfield and the impact factor. Ann. Rev. of Infor. Sci. Tech., 41(1): 93–155. doi: 10.1002/aris.2007.1440410110.
[48] Lawlor, B. 2014. The Institute for Scientific Information: A brief history. In: McEwen, L et al. (Ed.): The Future of the History of

Chemical Information, ACS Symposium Series, Vol. 1164. Washington, D.C.: American Chemical Society. pp. 109–126.

[49] Thomsen Reuters. 2016. Thomson Reuters Announces Definitive Agreement to Sell its Intellectual Property & Science Business to Onex and Baring Asia for $3.55 billion. New York, NY. http://thomsonreuters.com/en/press-releases/2016/july/thomson-reuters-announces-definitive-agreement-to-sell-its-intellectual-property-science-business.html. Accessed on [2016-04-09].

[50] Cision. Acquisition of the Thomson Reuters Intellectual Property and Science Business by Onex and Baring Asia completed. New York, NY: Cision PR Newswire. https://www.prnewswire.com/news-releases/acquisition-of-the-thomson-reuters-intellectual-property-and-science-business-by-onex-and-baring-asia-completed-300337402.html. Accessed on [2018-06-14].

[51] Clarivate Analytics. Web of Science Databases. Philadelphis, PA: Clarivate Analytics. 2018. https://clarivate.com/products/web-of-science/databases/. Accessed on [2018-03-23].

[52] Clarivate Analytics. Incites help: Journal Impact Factor. Philadelphis, PA: Clarivate Analytics. 2018. http://ipscience-help.thomsonreuters.com/inCites2Live/indicatorsGroup/aboutHandbook/usingCitationIndicatorsWisely/jif.html. Accessed on [2018-03-31].

[53] Clarivate Analytics. Master journal list: Scope notes. Philadelphis, PA: Clarivate Analytics. 2018. http://mjl.clarivate.com/scope/. Accessed on [2018-03-31].

[54] Clarivate Analytics. Incites Journal Citation Reports Help: What's New in Journal Citation Reports?: 2018 JCR release. Philadelphis, PA: Clarivate Analytics. 2018. http://ipscience-help.thomsonreuters.com/incitesLiveJCR/whatsNewGroup/whatsNewJCR.html. Accessed on [2018-03-23].

[55] Clarivate Analytics. 2017 Journal Citation Reports: Journals in the 2017 release of JCR. Philadelphis, PA: Clarivate Analytics. 2017. https://mafiadoc.com/2017-journal-citation-reports_5b85a2b8097c479e2e8b45e7.html. Accessed on [2018-11-09].

[56] Elsevier. Industrial Crops and Products. Amsterdam, The Netherlands: Elsevier B.V. 2018. https://www.journals.elsevier.com/industrial-crops-and-products. Accessed on [2018-03-24].

[57] SpringerLink. Paddy and Water Environment. Heidelberg, Germany: Springer Verlag. 2018. https://link.springer.com/journal/10333. Accessed on [2018-03-24].

[58] Hall C W, Olsen W C. The literature of agricultural engineering. Ithaca, New York: Cornell University Press, 1992; 416p.

[59] Basselman J A, Chancellor W. Publishing of the American Society of Agricultural Engineers. In: Hall C W, Olsen W C. (Ed.): The literature of agricultural engineering. Ithaca, New York: Cornell University Press, 1992; pp.175–196.

[60] Olsen W C. Primary journals and reports. In: Hall C W, Olsen W C. (Ed.): The literature of agricultural engineering. Ithaca, New York: Cornell University Press, 1992; pp.318–331.

[61] Wang Y, Tian C. Introduction of agricultural engineering journals embodied by databases of EI and SCI, etc. Transactions of the CSAE, 2012; 28(2): 316–322. (in Chinese)

[62] Zhang K, Wang L. Citation analysis on articles of Transactions of the CSAE cited by SCI journals. Transactions of the CSAE, 2017; 33(1): 381–387. (in Chinese).

[63] Larivière V, Haustein S, Mongeon P. The oligopoly of academic publishers in the digital era. PLOS One, 2015; 10(6): e0127502. doi: 10.1371/journal.pone.012750.

[64] DEAg-CTRN-UFCG. Revista Brasileira de Engenharia Agricola Ambiental: Instructions to the authors. Departamento de Engenharia Agrícola, Centro de Tecnologia e Recursos Naturais, Universidade Federal de Campina Grande. 2018. http://www.scielo.br/revistas/rbeaa/iinstruc.htm. Accessed on [2018-03-26].

[65] SBEA. Engenharia Agrícola: Instructions to authors. Brazilian Association of Agricultural Engineering, São Paulo State University, Castellane, São Paulo, Brazil. 2018. http://www.scielo.br/revistas/eagri/iinstruc.htm. Accessed on [2018-03-26].

[66] Elsevier. Biosystems Engineering: Open access options. Amsterdam. The Netherlands: Elsevier B.V. 2018. https://www.elsevier.com/journals/biosystems-engineering/1537-5110/open-access-options. Accessed on [2018-03-26].

[67] Elsevier. Aquacultural Engineering: Open access options. Amsterdam. The Netherlands: Elsevier B.V. 2018. https://www.elsevier.com/journals/aquacultural-engineering/0144-8609/open-access-options. Accessed on [2018-03-26].

[68] Springer. Open Choice: Your research; Your choice. Heidelberg, Germany: Springer Verlag. 2018. http://www.springer.com/us/open-access/springer-open-choice. Accessed on [2018-03-26].

[69] Creative Commons. About the licenses. Mountain View, California: Creative Commons. 2018. https://creativecommons.org/licenses/. Accessed on [2018-03-26].

[70] Clarivate Analytics. Incites Journal Citation Reports help: Total cites. Philadelphis, PA: Clarivate Analytics. 2018e. http://ipscience-help.thomsonreuters.com/incitesLiveJCR/glossaryAZgroup/g13/7411-TRS.html. Accessed on [2018-03-31].

[71] Clarivate Analytics. The clarivate analytics impact factor. Philadelphis, PA: Clarivate Analytics. 1994. https://clarivate.com/essays/impact-factor/. Accessed on [2018-03-31].

[72] Clarivate Analytics. Incites help: 5-year journal impact factor. Philadelphis, PA: Clarivate Analytics. 2018. http://ipscience-help.thomsonreuters.com/inCites2Live/indicatorsGroup/aboutHandbook/usingCitationIndicatorsWisely/fiveYearJIF.html. Accessed on [2018-03-31].

[73] Liu W, Liu F, Zuo C, Zhu J. The effect of publishing a highly cited paper on a journal's impact factor: A case study of the Review of Particle Physics. Learned Publishing, 2018. doi: 10.1002/leap.1156.

[74] Rawls W J, Brakensiek D L, Saxton S E. Estimation of Soil Water Properties. Transactions of the ASABE, 1982; 25(5): 1316–1320. doi: 10.13031/2013.33720.

[75] Williams J R, Jones C A, Dyke P T. A modeling approach to determining the relationship between erosion and soil productivity. Transactions of the ASABE, 1984; 27(1): 129–144

[76] Williams J R, Jones C A, Kiniry J R, Spanel D A. The EPIC crop growth model. Transactions of the ASABE, 1989; 32(2): 0497–0511. doi: 10.13031/2013.31032.

[77] Leonard R A, Knisel W G, Still D A. GLEAMS: Groundwater loading effects of agricultural management systems. Transactions of the ASABE, 1987; 30(5): 1403–1418. doi: 10.13031/2013.30578.

[78] Canakci M, Van Gerpen J. Biodiesel production from oils and fats with high free fatty acids. Transactions of the ASAE, 2001; 44(6): 1429–1436. doi: 10.13031/2013.7010.

[79] Canakci M, Van Gerpen J. Biodiesel production via acid catalysis. Transactions of the ASAE, 1999; 2(5): 1203–1210. doi: 10.13031/2013.13285.

[80] Nearing M A, G. R. Foster, L. J. Lane, S. C. Finkner. A process-based soil erosion model for USDA-Water Erosion Prediction Project Technology. Transactions of the ASABE, 1989; 32(5): 1587–1593. doi: 10.13031/2013.31195.

[81] Harmel R D, Cooper R J, Slade R M, Haney R L, Arnold J G. Cumulative uncertainty in measured streamflow and water quality data for small watersheds. Transactions of the ASABE, 2006; 49(3): 689–701. doi: 10.13031/2013.20488)

[82] Moriasi D N, Arnold J G, Van Liew M W, Bingner R L, Harmel R D, Veith T L. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of the ASABE, 2007; 50(3): 885−900. doi: 10.13031/2013.23153.

[83] Gassman P W, Reyes M, Green C, Arnold J G. The soil and water assessment tool: Historical development, applications, and future research directions. Trans ASABE, 2007; 50(4): 1211–50. doi: 10.13031/2013.23634.

[84] Arnold J G, Moriasi D N, Gassman P W, Abbaspour K C, White M J, Srinivasan R, et al. SWAT: Model use, calibration, and validation. Transactions of the ASABE, 2012; 55(4): 1491–1508. doi: 10.13031/2013.42256.

[85] Liu W, Tang L, Gu M, Hu G. Feature report on China: A bibliometric analysis of China-related articles. Scientometrics, 2015; 102(1): 503–517. doi: 10.1007/s11192-014-1371-y.

[86] Liu W, Hub G, Tang L, Wang Y. China's global growth in social science research: Uncovering evidence from bibliometric analyses of SSCI publications (1978–2013). Journal of Informetrics, 2015; 9(3): 555–569. doi: 10.1016/j.joi.2015.05.007. (in Chinese)

[87] Cobo M J, Martínez M A, Gutiérrez-Salcedo M, Fujita H, Herrera-Viedma E. 25 years at Knowledge-Based Systems: A bibliometric analysis. Knowledge-Based Systems, 2015; 80: 3–13. doi: 10.1016/j.knosys.2014.12.035.

[88] Mao G, Zou H, Chen G, Du H, Zuo J. Past, current and future of biomass energy research: A bibliometric analysis. Renewable and Sustainable

Energy Reviews, 2015; 52: 1823–1833. doi: 10.1016/j.rser.2015.07.141.
[89] Chen H-Q, Wang X, He L, Chen P, Wan Y, Yang L, et al. Chinese energy and fuels research priorities and trend: A bibliometric analysis. Renewable and Sustainable Energy Reviews, 2016; 58: 966–975. doi: 10.1016/j.rser.2015.12.239.
[90] Wang M, Liu D, Jia J, Zhang X. Global trends in soil monitoring research from 1999–2013: a bibliometric analysis. Acta Agriculturae Scandinavica, Section B: Soil & Plant Science, 2015; 65(6): 483–495. doi: T10.1080/09064710.2015.1030443.
[91] Wang Y, Xiang C, Zhao P, Mao G, Du H. A bibliometric analysis for the research on river water quality assessment and simulation during 2000–2014. Scientometrics, 2016; 108(3): 1333–1346. doi: 10.1007/s11192-016-2014-2.
[92] Wang L. The structure and comparative advantages of China's scientific research: quantitative and qualitative perspectives. Scientometrics, 2016; 106: 435–452. doi: 10.1007/s11192-015-1650-2. (in Chinese)
[93] Mosier N, Wyman C, Dale B, Elander R, Lee, Y Y , Holtzapple M, et al. Features of promising technologies for pretreatment of lignocellulosic biomass. Bioresource Technology, 2004; 96(6): 673–686. doi: 10.1016/j.biortech.2004.06.025.
[94] Allen R G, Tasumi M, Trezza R. Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC) – model. Journal of Irrigation and Drainage Engineering, 2007; 133(4): 380–394. doi: 10.1061/(ASCE)0733-9437(2007)133:4(380).
[95] Alvira P, Tomas-Pejo E, Ballesteros M, Negro M J. Pretreatment technologies for an efficient bioethanol production process based on enzymatic hydrolysis: A review. Bioresource Technology, 2010; 101(13): 4851–4861. doi: 10.1016/j.biortech.2009.11.093.
[96] Stone, M L, Solie, J B, Raun, W R, Whitney, R W, Taylor, S L, Ringer, J D. Use of spectral radiance for correcting in-season fertilizer nitrogen deficiencies in winter wheat. Transactions of the ASAE, 1996; 39(5): 1623–1631. doi: 10.13031/2013.27678.
[97] Thompson J C, He B B. Characterization of crude glycerol from biodiesel production from multiple feedstocks. Applied Engineering in Agriculture, 2006; 22(2): 261–265. doi: 10.13031/2013.20272.
[98] Buffington D E, Collazo-Arocho A, Canton G H, Pitt D, Thatcher W W, Collier R J. Black Globe-Humidity Index (BGHI) as comfort equation for dairy cows. Transactions of the ASABE, 1981; 24(3): 0711–0714. doi: 10.13031/2013.34325.
[99] Thomsen Reuters. Connecting the dots across the research ecosystem: A white paper. 2014. Available at: wokinfo.com/media/pdf/connecting_the_dots.pdf. Accessed on [2018-02-18].
[100] ASCE. ASCE library: journals. Reston, VA: American Society of Civil Engineers. https://ascelibrary.org/journals. Accessed on [2018-15-06].
[101] Clarivate Analytics. Incites journal citation reports help: Cited journal data. Philadelphis, PA: Clarivate Analytics. 2018. http://ipscience-help.thomsonreuters.com/incitesLiveJCR/JCRGroup/jcrJournalProfile/jcrJournalProfileCitedJournal.html. Accessed on [2018-08-06].
[102] Clarivate Analytics. Incites journal citation reports help: Citing journal data. Philadelphis, PA: Clarivate Analytics. 2018. http://ipscience-help.thomsonreuters.com/incitesLiveJCR/JCRGroup/jcrJournalProfile/jcrJournalProfileCitingTab.html. Accessed on [2018-08-06].
[103] Elsevier. Computers and Electronics in Agriculture. Amsterdam, The Netherlands: Elsevier B.V. 2018. https://www.journals.elsevier.com/computers-and-electronics-in-agriculture. Accessed on [2018-06-13].
[104] Leydesdorff L, Rafols I. A global map of science based on the ISI subject categories. Journal of the American Society for Information Science and Technology, 2009; 60(2): 348–362. doi: 10.1002/asi.20967.
[105] INMA. INMATEH – Agricultural Engineering. Bucharest, Romania: National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry – INMA. http://www.inmateh.eu/index_eng.htm. Accessed on [2018-13-06].
[106] CAAS. Research in Agricultural Engineering (RAE). Czech Academy of Agricultural Sciences, Prague, Czech Republic. https://www.agriculturejournals.cz/web/rae/. Accessed on [2018-09-09].
[107] Clarivate Analytics. Evaluate the world's leading scientific and scholarly journals: Using the Journal Impact Factor wisely. Philadelphis, PA: Clarivate Analytics. 2017. https://clarivate.com/products/journal-citation-reports/. Accessed on [2018-16-06].
[108] SpringerLink. Applied Biological Chemistry. Heidelberg, Germany: Springer Verlag. 2018. https://link.springer.com/journal/13765. Accessed on [2018-03-24].

Appendix A: JCR or WoS search structures for information of data reported in the Introduction, Tables 9 and 10, and Section 4.2

Introduction: The identification of the beginning of the JCR AE category was determined by searching on selected years in the current Incites Journal Citation Reports database, within the overall Web of Science database. Selecting the year 1999 reveals that the Agricultural Engineering category does not exist. However, selecting the year 2000 shows the Agricultural Engineering category for the first time (with nine journals listed). Some of the originally indexed agricultural engineering journals (e.g., *T ASAE* and *J Agr Eng Res*) are indexed prior to the year 2000 in the JCR Engineering category.

Table 9: This advanced search structure includes all of the relevant journals that were indexed in the 2017 JCR AE category (see Table 1), plus the Journal of Agricultural Engineering Research and T ASAE (which are the original names for Biosyst Eng and T ASABE).

SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or INT J AGR BIOL ENG or J IRRIG DRAIN ENG or J AGR ENG RES or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASAE or T ASABE)

Note: The Table 9 search structure does not include APPL BIOL CHEM, which is the new name that was adopted in 2016 for the original J KOREAN SOC APPL BI (as listed in Tables A.1, A.2, A.4 and A.5). The old name was indexed in the 2016 and 2017 JCR data, as explained in the main text and Appendix A. The name was indexed in the 2016 WoS CC.

Table 10: This search structure includes the relevant comprehensive agricultural journals (see Table 1) that were indexed in the 2017 JCR AE category, plus the Journal of Agricultural Engineering Research and T ASAE (which are the original names for Biosyst Eng and T ASABE)

SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or BIOSYST ENG or ENGENHARIA AGRICOLA or INT J AGR BIOL ENG or J AGR ENG RES or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASAE or T ASABE)

Water Resources category search: As noted in Section 4.2, an advanced WoS CC search was performed for the Water Resources category to determine the 100 highest cited articles cited in that category (to compare against top cited T ASABE/T ASAE water quality and soil property related articles). There are currently 88 journals indexed in the JCR Water Resources category, which were too many to perform a "SO search" such as were performed for Tables 9 and 10 as described above. So a general search using the "WC" command (described further in Appendix C) was performed as follows:

WC = Water Resources

The search resulted in returning a listing of 280 979 articles that were indexed in the Water Resources category as of June 5, 2018.

Appendix B: Versions of Tables 1, 2, 4 and 5, and Figures 1 and 2, that include information for *The Journal of the Korean Society for Applied Biological Chemistry*

The revelation that *The Journal of the Korean Society for Applied Biological Chemistry* (*J Korean Soc Appl Bi*) was included by mistake in the 2016 and 2017 JCR AE journal categories (Hubbard, S. Personal communication. 2018. Content Team Lead, JCR, Clarivate Analytics, Philadephia, PA) posed a dilemma for this study. Excluding the *Korean Soc Appl Bi* from the study would result in an inconsistent set of journals per those that were actually reported in the JCR over those two years. However, including the journal in the study would result in essentially meaningless journal metric comparisons and other analyses, because the *J Korean Soc Appl Bi* was actually never intended to be compared with the other journals indexed in the JCR AE and WoS CC AE categories.

To address this conundrum, the decision was made to exclude the *J Korean Soc Appl Bi* from the primary study but to also provide several parallel tables and figures in this appendix that include data for the journal. No additional supporting text is provided in this appendix for these parallel tables and figures, but comparisons can be made between them and those in the text to gain insights as to how the *J Korean Soc Appl Bi* would have ranked versus the other journals for several measures. The table and figure numbering is consistent with the comparable tables reported in the text.

Table B.1 Classifications, JIF rank, journal titles, professional society, publisher and publication characteristics for the 14 journals indexed in the 2017 JCR Agricultural Engineering Category (including the *J Korean Soc Appl Bi*)[a]

Classification	JIF Rank[b]	Full journal title	Abbreviated journal title[c]	Society[d] (country)	Publisher (country)	Publication frequency	Initial year	Publication model[e]
Specialty topic agricultural engineering journals (abbreviation: specialty)	1	Bioresource Technology	Bioresource Technol	NA[f]	Elsevier B.V. (The Netherlands)	< monthly	1991	Traditional (supports OA)
	2	Biomass & Bioenergy	Biomass Bioenerg	NA	Elsevier B.V. (The Netherlands)	Monthly	1991	Traditional (supports OA)
	3	Industrial Crops and Products	Ind Crop Prod	NA	Elsevier B.V. (The Netherlands)	Monthly to < monthly	1992	Traditional (supports OA)
	5	Journal of Irrigation and Drainage Engineering	J Irrig Drain Eng	ASCE (United States)	ASCE (United States)	Monthly	1956	Traditional
	6	Aquacultural Engineering	Aquacult Eng	AES (United States)	Elsevier B.V. (The Netherlands)	Quarterly to bimonthly	1982	Traditional (supports OA)
	8	Paddy and Water Environment	Paddy Water Environ	PAWEES (Japan)	Springer Verlag (Germany)	Quarterly	2003	Traditional (supports OA)
	10	Journal of the Korean Society for Applied Biological Chemistry[g]	J Korean Soc Appl Bi	KSABC (South Korea)	Springer Verlag (Germany)	Bimonthly	1948	Traditional
Comprehensive agricultural engineering journals (abbreviation: comprehensive)	4	Biosystems Engineering	Biosyst Eng	EurAgEng (United Kingdom)	Elsevier B.V. (The Netherlands)	Monthly	2002[g]	Traditional (supports OA)
	7	Transactions of the ASABE	T ASABE	ASABE (United States)	ASABE (United States)	Bimonthly	1958	Traditional
	9	International Journal of Agricultural and Biological Engineering	Int J Agr Biol Eng	CSAE & AOCABFE (Peoples R China)	CASE (Peoples R China)	Bimonthly	2008	Open access
	11	Revista Brasileira de Engenharia Agricola e Ambiental	Rev Bras Eng Agr Amb	NA	DEAg-CTRN-UFCG[i] (Brazil)	Monthly	1997	Open access
	12	Applied Engineering in Agriculture	Appl Eng Agric	ASABE (United States)	ASABE (United States)	Bimonthly	1985	Traditional
	13	Engenharia Agricola	Eng Arg-Jaboticabal	SBEA (Brazil)	SBEA (Brazil)	Bimonthly	1972	Open access
	14	AMA-Agricultural Mechanization in Asia Africa and Latin America	Ama-Arg Mech Asia Af	NA	Shin-Norinsha Co., Ltd. (Japan)	Quarterly	1971	Traditional

Note: [a] The 2017 JCR[54,55] reports citation data recorded in 2016.

[b] JIF rank is reported in the 2017 JCR as listed in Table 5 in section 2.2.

[c] Abbreviated journal title names as reported in the JCR Agricultural Engineering category.

[d] Definitions of society abbreviations: AES = Aquacultural Engineering Society (https://www.aesweb.org/); ASCE = American Society of Civil Engineering (https://www.asce.org/); PAWEES = International Society of Paddy and Water Environment Engineering (http://pawees.net/); KSABC = The Korean Society for Applied Biological Chemistry (http://www.ksabc.or.kr/ english/); EurAgEng = European Society for Agricultural Engineers (https://www.eurageng.eu/); CSAE = Chinese Society of Agricultural Engineering (http://www.csae.org.cn/); AOCABFE = Association of Overseas Chinese Agricultural, Biological, and Food Engineers (http://aocabfe.com/); ASABE = American Society of Agricultural and Biological Engineers (http://www.asabe.org/); SBEA = Brazilian Association of Agricultural Engineering (http://www.sea.org.br/)

[e] Traditional = no articles are published open access; Traditional (supports OA) = open access articles are possible for a fee; open access = all of the articles are published open access (also requires publication fees)

[f] NA = not applicable

[g] The journal name was changed in 2016 to Applied Biological Chemistry[108][h] *Biosyst Eng* was previously published as the *J Agr Eng Res* between 1956 and 2001[32]

[i] DEAg-CTRN-UFCG = Departamento de Engenharia Agrícola, Centro de Tecnologia e Recursos Naturais, Universidade Federal de Campina Grande (http://www.scielo.br/revistas/rbeaa/iaboutj.htm).

Table B.2 Total number of articles published in each of the 14 journals (including the *J Korean Soc Appl Bi*) indexed in the JCR Agricultural Engineering category for 2015 and 2016[a]

JCR journal title	Total articles	Proportion/%	Total articles	Proportion/%
	2015		2016	
Bioresource Technol	1537	37.69	1615	40.12
Ind Crop Prod	937	22.98	713	17.71
Biomass Bioenerg	356	8.73	317	7.88
Biosyst Eng	164	4.02	193	4.80
Aquacult Eng	52	1.28	45	1.12
J Irrig Drain Eng	158	3.87	176	4.37
Int J Agr Biol Eng	106	2.60	133	3.30
T ASABE	154	3.78	203	5.04
Paddy Water Environ	51	1.25	47	1.17
J Korean Soc Appl Bi	122	2.99	111	2.76
Rev Bras Eng Agr Amb	180	4.41	180	4.47
Appl Eng Agric	95	2.33	104	2.58
Eng Agr-Jaboticabal	113	2.77	125	3.11
Ama-Agr Mech Asia Af	53	1.30	63	1.57
Total	4078	100	4025	100

Note: [a] Reported in the WoS CC AE data[51].

Table B.4 Primary research areas covered by specialty topic journals[a] in the JCR Agricultural Engineering category including the *J Korean Soc Appl Bi*

Journal[b]	Additional JCR categories	Primary research topics
Bioresource Technol	Biotechnology & Applied Microbiology; Energy & Fuels	Biofuels, bioprocesses and bioproducts; biomass and feedstocks utilization, thermochemical conversion of biomass, biological waste treatment
Ind Crop Prod	Agronomy	Industrial (i.e., non-food/non-feed) crops and products, including aspects of cultural practices, germplasm development and breeding, and new crop types
Biomass Bioenergy	Biotechnology & Applied Microbiology; Energy & Fuels	Biomass, biological residues, bioenergy processes, bioenergy utilization, biomass and the environment
Aquacult Eng	Fisheries	Engineering and design, construction experience and techniques, in-service experience, commissioning and operation, materials selection and uses, and quantification of biological data/constraints, related to aquaculture facilities
J Irrig Drain Eng	Engineering; Civil; Water Resources	All phases of irrigation, drainage, engineering hydrology, and related water management subjects including water quality, groundwater and surface water
Paddy Water Environ	Agronomy	Irrigation and drainage, soil and water conservation, land and water resources management, paddy multi-functionality, and other aspects of paddy farming
J Korean Soc Appl Bi	Food Science and Technology	Biochemistry, molecular biology, biotechnology, natural and synthetic bioactive compounds, and bio-environmental interactions

Note: [a] See Table 1 for additional details about each journal.
[b] Sources: Bioresource Technol (https://www.journals.elsevier.com/bioresource-technology/); Ind Crop Prod (https://www.journals.elsevier.com/industrial-crops-and-products); Biomass Bioenergy (https://www.journals. elsevier.com/biomass-and-bioenergy); Aquacult Eng (https://www.journals.elsevier.com/aquacultural-engineering); J Irrig Drain Eng (https://ascelibrary.org/page/jidedh/editorialboard); Paddy Water Environ (https://link.springer.com/journal/10333); J Korean Soc Appl Bi (https://link.springer.com/journal/13765).

Table B.5 Total cites, JIF and 5-year JIF values reported for the 14 JCR Agricultural Engineering category journals (including the *J Korean Soc Appl Bi*) for citation data recorded in 2016[a]

Journal title	Total cites	JIF	5-Year JIF	Classification
Bioresource Technol	93 612	5.651	6.102	specialty
Biomass Bioenerg	18 312	3.219	4.186	specialty
Ind Crop Prod	15 116	3.181	3.577	specialty
Biosyst Eng	4495	2.044	2.238	comprehensive
J Irrig Drain Eng	3434	1.983	1.842	specialty
Aquacult Eng	1917	1.559	2.004	specialty
T ASABE	8412	0.975	1.264	comprehensive
Paddy Water Environ	609	0.916	1.218	specialty
Int J Agr Biol Eng	503	0.835	-	comprehensive
J Korean Soc Appl Bi	630	0.750	0.671	specialty
Rev Bras Eng Agr Amb	1311	0.608	0.78	comprehensive
Appl Eng Agric	1590	0.505	0.667	comprehensive
Eng Agr-Jaboticabal	686	0.353	0.59	comprehensive
Ama-Agr Mech Asia Af	106	0.118	0.087	comprehensive

Note: [a] 2016 statistics are reported in the 2017 JCR published by Clarivate Analytics[54,55].

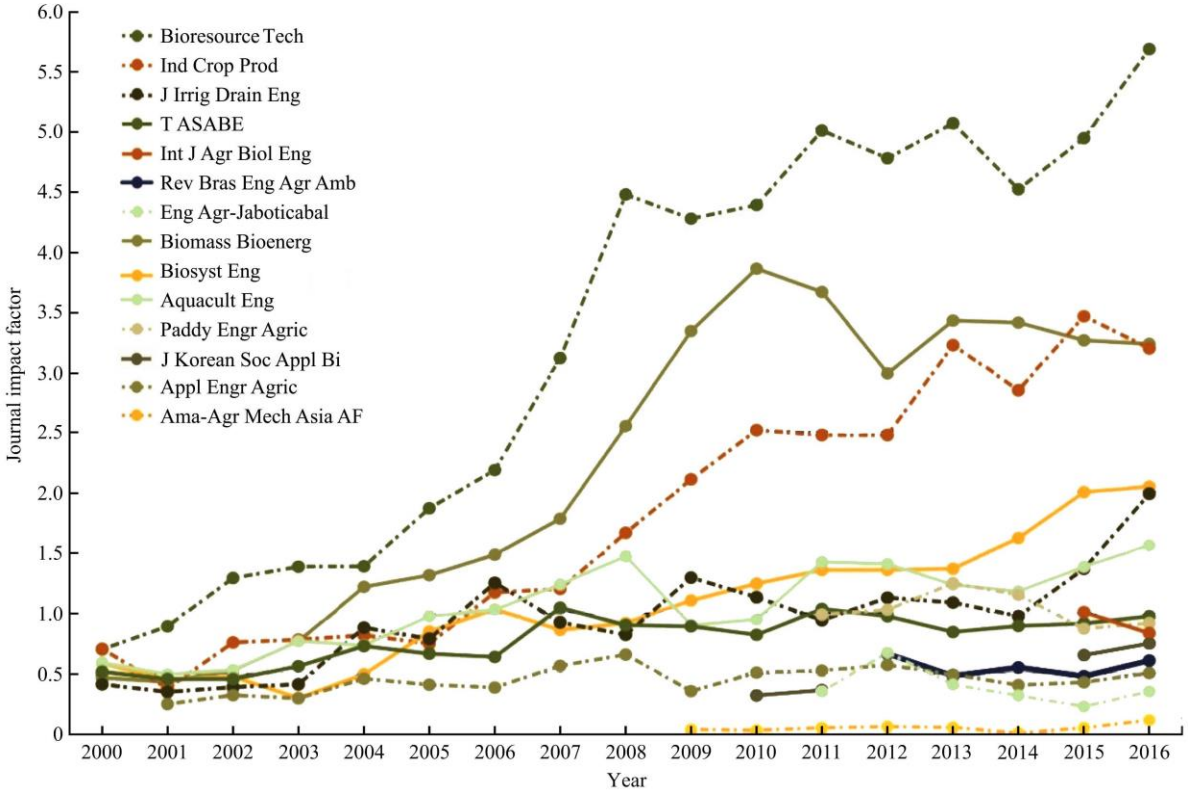

Figure B.1 Long-term trends in JIF values for the 14 journals indexed in the JCR Agricultural Engineering category including the *J Korean Soc Appl Bi*[54]

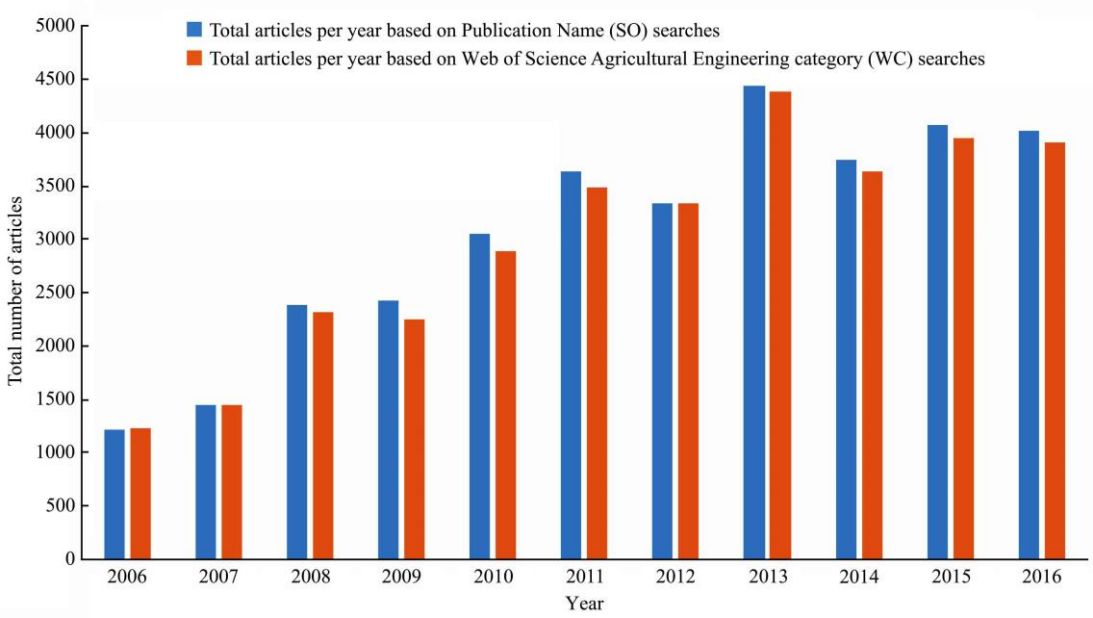

Figure B.2 Total articles indexed in the WoS Core Collection Agricultural Engineering category, including the *J Korean Soc Appl Bi*, using two different types of search structures as described in Appendix C

Appendix C. JIF values based on 2017 citation data, and extended long-term JIF trends, for the journals reported in the 2018 JCR AE category

The data included in Appendix C includes the JIF values reported for the 2018 JCR AE category journals, based on 2017 citation data and long-term JIF trends for the journals that include the JIF values reported in the 2018 JCR. The error that resulted in the *J Korean Soc Appl Bi* being included in the 2016 and 2017 JCR AE categories occurred again for the 2018 JCR (A. Prasad. Personal communication. 2018. Customer Care - Technical Support, Clarivate Analytics, Philadephia, PA). Thus Table C.1 reports the 2018 JCR JIF values without the *J Korean Soc Appl Bi* data and is analogous to Table 5 in the text. Table C.2 includes the *J Korean Soc Appl Bi* data and is analogous to Table B.5 in Appendix B. Similarly, Figures C.1 and C.2 reflect the exclusion and inclusion of the *J Korean Soc Appl Bi* data, respectively, and are identical to the respective Figure 1 in the text or Figure B.1 in Appendix B except that 2017 citation data is included for each of the AE journals.

Table C.1 Total cites, JIF and 5-year JIF values reported for the 13 JCR Agricultural Engineering category journals (excluding the *J Korean Soc Appl Bi*) for citation data recorded in 2017[a]

Journal title	Total cites	JIF	5-Year JIF	Classification
Bioresource Technol	101 191	5.807	5.978	specialty
Ind Crop Prod	19 421	3.849	4.072	specialty
Biomass Bioenerg	19 706	3.358	4.232	specialty
Biosyst Eng	5 044	2.132	2.325	comprehensive
J Irrig Drain Eng	3 468	1.616	1.714	specialty
Aquacult Eng	1 957	1.490	2.111	specialty
Paddy Water Environ	703	1.379	1.293	specialty
Int J Agr Biol Eng	765	1.267	-	comprehensive
T ASABE	9 260	1.118	1.475	comprehensive
Rev Bras Eng Agr Amb	1 523	0.619	0.801	comprehensive
Appl Eng Agric	1 796	0.497	0.698	comprehensive
Eng Agr-Jaboticabal	707	0.387	0.611	comprehensive
AMA-Agr Mech Asia Af	107	0.150	0.147	comprehensive

Note: [a] 2017 statistics are reported in the 2018 JCR published by Clarivate Analytics[54].

Table C.2 Total cites, JIF and 5-year JIF values reported for the 13 JCR Agricultural Engineering category journals (including the *J Korean Soc Appl Bi*) for citation data recorded in 2017[a]

Journal title	Total cites	JIF	5-Year JIF	Classification
Bioresource Technol	101 191	5.807	5.978	specialty
Ind Crop Prod	19 421	3.849	4.072	specialty
Biomass Bioenerg	19 706	3.358	4.232	specialty
Biosyst Eng	5 044	2.132	2.325	comprehensive
J Irrig Drain Eng	3 468	1.616	1.714	specialty
Aquacult Eng	1 957	1.490	2.111	specialty
Paddy Water Environ	703	1.379	1.293	specialty
Int J Agr Biol Eng	765	1.267	-	comprehensive
J Korean Soc Appl Bi	686	1.129	0.840	specialty
T ASABE	9 260	1.118	1.475	comprehensive
Rev Bras Eng Agr Amb	1 523	0.619	0.801	comprehensive
Appl Eng Agric	1 796	0.497	0.698	comprehensive
Eng Agr-Jaboticabal	707	0.387	0.611	comprehensive
AMA-Agr Mech Asia Af	107	0.150	0.147	comprehensive

Note: [a] 2017 statistics are reported in the 2018 JCR published by Clarivate Analytics[54].

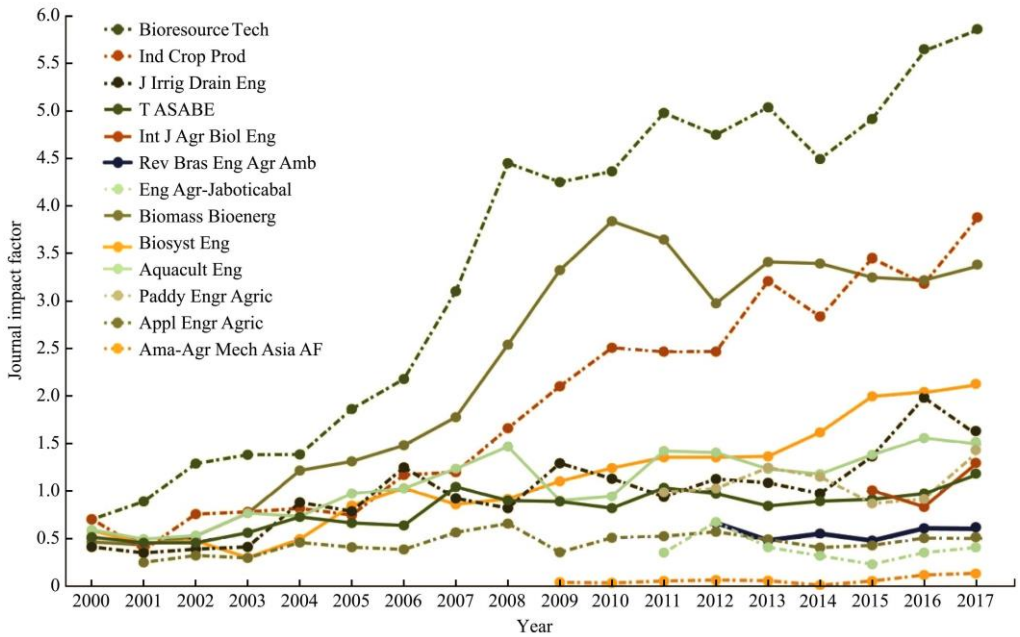

Figure C.1 Long-term trends in JIF values for the 14 journals indexed in the JCR Agricultural Engineering category excluding the *J Korean Soc Appl Bi*[54]

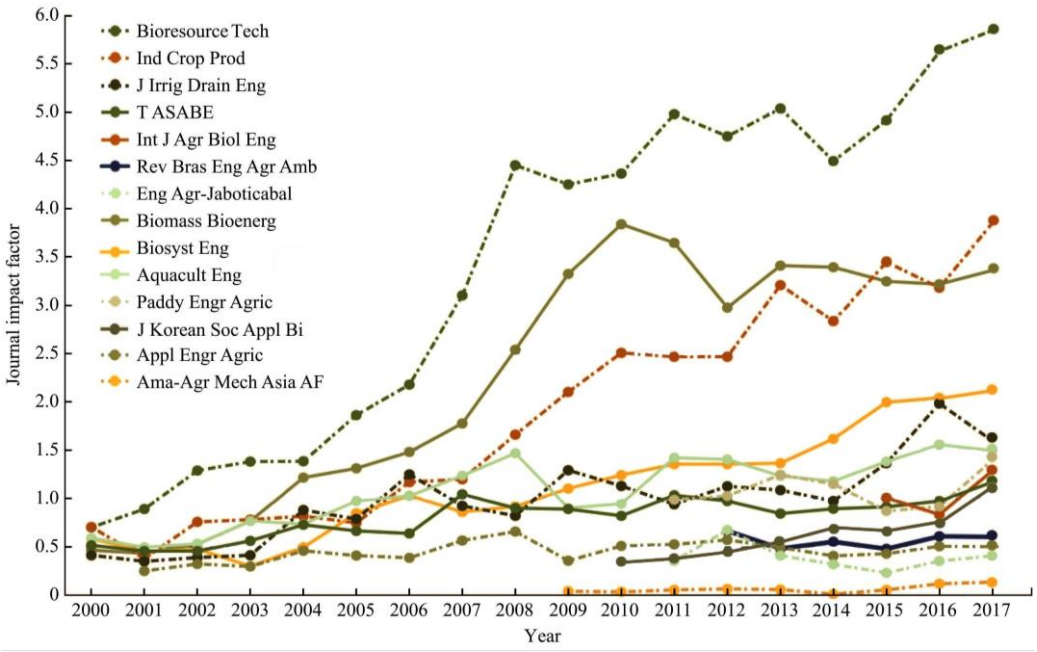

Figure C.2 Long-term trends in JIF values for the 14 journals indexed in the JCR Agricultural Engineering category including the *J Korean Soc Appl Bi*[54]

Appendix D. Description of Searches for Agricultural Engineering Journals, and Resulting Total Published Articles by Year, that are Indexed in the WoS Core Collection

Section 3 describes data generated using ad vanced searches within the WoS Core Collection Agricultural Engineering category, such as the total articles published in the category by year (Figure 2). The WoS platform provides two methods for performing advanced searches that return the total number of articles and other data related to the journals indexed in a specific WoS category, which are as follows:

1) WC = Web of Science Category

2) SO = Publication name, which is constructed as: SO = (journal name 1 or journal name 2 or …, etc.)

As noted in Section 3, "apparent anomalies" were encountered regarding how some of the journals are indexed in the JCR Agricultural Engineering category versus the WoS Core Collection Agricultural Engineering category (and also internally within the WoS Core Collection). However, explanations for these discrepancies were provided by Clarivate Analytics, which are described in more detail below along with corresponding adjustments that were incorporated in the search structures. Results of both search methods are reported in Figure 2, which vary in total articles reported for each year.

Regarding the two search methods described above, the first was very straight forward and simply consisted of using "WC = Agricultural Engineering" for each year between 2006 and 2016, to determine the total number of articles published in the category each year. The search was also limited to just the SCIE database, out of the ten different WoS databases that were available. Otherwise, potentially hundreds of additional articles are reported, which are published in numerous other journals, conference proceedings and other publications that are indexed in various non-SCIE WoS databases (e.g., ESCI, CPCI-S). The results of the WC searches are reported in the respective WC columns by year in Table D.1.

The SO search structures required identifying the appropriate sets of journals each year, based on which sets of journals were reported in the JCR between 2006 and 2016. The specific SO search structures are listed below by year, including explanations as to why certain journals were excluded or included, based partially on the guidance provided by Clarivate Analytics.

Several of the journals were indexed in both the JCR and WoS Core Collection Agricultural Engineering categories across the entire time period and thus appear in every search. Those journals included *Appl Eng Agric*, *Aquacult Eng*, *Biomass Bioenerg*, *Bioresource Technol*, *Biosyst Eng*, *Ind Crop Prod*, *J Irrig Drain Eng* and *T ASABE* (although *J Irrig Drain Eng-ASCE* had to also be used for *J Irrig Drain Eng* for several years as discussed below). Several other journals were indexed one or more years later than 2006, initially in the WoS Core Collection and then two years later in the JCR AE category; i.e., *Agrartech Forsch-Agr*, *AMA-Agr Mech Asia Af*, *Eng Agr-Jaboticabal*, *Rev Bras Eng Agr Amb* and *Int J Agr Biol Eng*, which were indexed respectively in the Core Collection in 2007, 2007, 2008, 2010 and 2013, and then subsequently in the JCR in 2009, 2009, 2010, 2012 and 2015 (*Agrartech Forsch-Agr* was only indexed for one year in both databases, due to the journal ceasing publication in 2008).

The apparent anomalies pertained to the following journals listed listed in Table D.1: *J Irrig Drain Eng*, *J Irrig Drain Eng-ASCE* and *Paddy Water Environ*. Problems were also encountered that pertained to *J Korean Soc Appl Bi* (and revised title *Appl Biol Chem* in 2016). Explanations for these issues are provided below based on the responses provided by Clarivate Analytics (Hubbard, S. Personal communication. Content Team Lead, JCR, Clarivate Analytics, Philadephia, PA). The adjustments for the search structures are listed below each explanation. A standard rule that was adopted within the search structures, as part of some of the solutions, is the assumption that a journal was indexed in the WoS CC AE category two years before it first appears in the JCR AE category. This is consistent with the relationship that exists for other indexed agricultural engineering journals as described above.

The apparent anomalies encountered, the explanations based on the guidance provided by Clarivate Analytics (which are summarized here)

and the adjustments adopted for the SO search structures are as follows:

1) *Irrigation Sci* is listed in the JCR AE category but not in the WoS AE category for the years 2006 to 2010.

Explanation: *Irrigation Sci* was originally indexed in the JCR AE category for the years 2006 to 2010. But the 2006 to 2010 WoS categories now reflect just the current indexing of *Irrigation Sci* in the Agronomy and Water Resources categories.

Adjustment: This change was overcome by incorporating *Irrigation Sci* in the SO search structures for 2006 to 2010.

2) The titles *J Irrig Drain Eng* and *J Irrig Drain Eng-ASCE* are used for the same journal in the WoS Agricultural Engineering category during the years 2006 to 2013. However, the journal is listed only as the *J Irrig Drain Eng-ASCE* in the JCR Agricultural Engineering category during 2006 to 2012 and as *J Irrig Drain Eng* during 2013 to 2016 (implying a journal name change between 2012 and 2013).

Explanation: The journal title and abbreviation were in fact changed in the JCR and WoS in 2013 by dropping the *–ASCE* suffix (the same change was made for several other American Society of Civil Engineering journals at that time per the society's request). A general recommendation is to be inclusive as possible in the search structure to account for possible differences in the journal source title.

Adjustment: Both titles were used in the initial SO searchers between 2006 and 2013 to ensure that all of the articles that were published in the journal during those years were accounted for. Interestingly, it was discovered that the *J Irrig Drain Eng-ASCE* title disappeared several weeks later (by June 25, 2018) and that searching on just *J Irrig Drain Eng* returned all of the articles published in each year (as shown in Table D.1).

3) *Paddy Water Environ* is indexed in the WoS CC AE category during 2006 to 2008 but is not indexed in the JCR AE category during those same three years.

Explanation: *Paddy Water Environ* was accepted to the WoS CC (SCIE Database) in 2009 and later indexed in the JCR in 2011. However, previous issues were backfilled into the WoS CC for 2003 to 2008.

Adjustment: *Paddy Water Environ* was included in the SO searches starting in 2009.

4) *J Korean Soc Appl Bi* is indexed in the JCR Agricultural Engineering category in 2011, 2012, 2015 and 2016 but is not indexed in the WoS CC AE category during those four years.

Explanation: The journal was indexed correctly in the 2011 and 2012 JCR AE categories but was incorrectly indexed in the 2016 and 2017 JCR AE categories.

Adjustment: The journal was excluded from all SO searches, to remain consistent with the decision to not include the *J Korean Soc Appl Bi* in the overall analyses (see Introduction, Table 1 and Appendix A).

5) The title of *J Korean Soc Appl Bi* was changed to *Appl Biol Chem* in 2016 as described at https://www.springer.com/chemistry/biotechnology/journal/13765?detailsPage=press (also noted in footnote G, Table B1 in Appendix B). The correct revised title is indexed in the WoS CC AE category in 2016 but still appears as *J Korean Soc Appl Bi* the 2017 JCR AE category.

Explanation: Both titles appear in the 2017 JCR data, the former with a Journal Impact Factor, and the latter with an Immediacy Index only. This is due to the normal sequence of events that occurs when a journal changes title in the JCR.

Adjustment: As noted for anomaly 4 immediately above, the journal was excluded from all SO searches, to remain consistent with the decision to not include the *J Korean Soc Appl Bi* in the overall analyses (this also applied to the new title that was adopted in 2016). And this is consistent with the results of the WC searches because the *J Korean Soc Appl Bi* never appears in any of those searches, including 2010 and 2011 when the *J Korean Soc Appl Bi* was correctly indexed in the JCR AE category.

However, a version of Figure 2 (Figure B.2) is shown in Appendix B that does include the *J Korean Soc Appl Bi* for selected SO search years (2008 to 2011 and 2013 to 2016), which accounts for the rule stated above that a journal was indexed in the WoS CC AE category two years before it first appears in the JCR AE category.

6) Incorrect search results (under accounting) were obtained within SO searches when the abbreviated journal titles *Eng Agr-Jaboticabal* during 2008 to 2010 and *J Irrig Drain Eng* in 2009 and 2011 to 2013, as compared to the total articles found for those abbreviated titles in the respective WC searches (Table D.1).

Explanation: These journals had abbreviation changes in 2010 and 2013, respectively. This again points to the need to have more inclusive search structures (similar to # 2 above), which in this case was facilitated by using the full journal titles.

Adjustment: The full journal titles were used for these two journals and in all of the pertinent SO searches. Ultimately, the full title was also used for *Revista Brasileira de Engenharia Agricola e Ambiental* for affected SO searchers, for the same reasons.

Following are the exact SO searches used for each year during the 2006 to 2016 time period:

2006: SO = (APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or IND CROP PROD or IRRIGATION SCI or J IRRIG DRAIN ENG or T ASABE)

2007: SO = (AGRARTECH FORSCH-AGR or AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or IND CROP PROD or IRRIGATION SCI or J IRRIG DRAIN ENG or T ASABE)

2008: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or IRRIGATION SCI or J IRRIG DRAIN ENG or T ASABE)

2009: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or IRRIGATION SCI or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or T ASABE)

2010: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or IRRIGATION SCI or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)

2011: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)
2012: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)
2013: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or INT J AGR BIOL ENG or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)
2014: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or INT J AGR BIOL ENG or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)
2015: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or INT J AGR BIOL ENG or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)
2016: SO = (AMA-AGR MECH ASIA AF or APPL ENG AGRIC or AQUACULT ENG or BIOMASS BIOENERG or BIORESOURCE TECHNOL or BIOSYST ENG or ENGENHARIA AGRICOLA or IND CROP PROD or INT J AGR BIOL ENG or J IRRIG DRAIN ENG or PADDY WATER ENVIRON or REVISTA BRASILEIRA DE ENGENHARIA AGRICOLA E AMBIENTAL or T ASABE)

Table D.1 Total annual published articles reported for journals indexed in the WoS CC AE category using two different search options (described above): Web of Science Category (WC) or Publication Name (SO)

Journal title (WoS abbreviated name)	Year and type of search																					
	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO	WC	SO
AGRARTECH FORSCH-AGR	0	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AMA-AGR MECH ASIA AF	0	0	62	62	46	46	81	81	59	59	61	61	53	53	61	61	57	57	53	53	63	63
APPL BIOL CHEM[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111
APPL ENG AGRIC	110	110	98	98	99	99	103	103	111	111	115	115	101	101	104	104	99	99	95	95	104	104
AQUACULT ENG	63	63	59	59	34	34	43	43	34	34	30	30	39	39	67	67	60	60	52	52	45	45
BIOMASS BIOENERG	127	127	95	95	147	147	203	203	231	231	570	570	433	433	391	391	418	418	356	356	317	317
BIORESOURCE TECHNOL	337	337	509	509	1231	1231	1035	1035	1458	1458	1656	1656	1566	1566	1987	1987	1498	1498	1537	1537	1615	1615
BIOSYST ENG	162	162	166	166	182	182	172	172	158	158	129	129	125	125	154	154	160	160	164	164	193	193
ENG AGR-JABOTICABAL	0	0	0	0	77	77	70	70	97	97	121	121	120	120	124	124	122	122	113	113	125	125
IND CROP PROD	82	82	78	78	108	108	166	166	191	191	244	244	322	322	879	879	574	574	937	937	713	713
INT J AGR BIOL ENG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	91	91	106	106	133	133
IRRIGATION SCI	0	30	0	37	0	49	0	50	0	37	0	0	0	0	0	0	0	0	0	0	0	0
J IRRIG DRAIN ENG	105	105	88	88	127	127	130	131	138	138	104	104	145	145	144	144	124	124	158	158	176	176
J KOREAN SOC APPL BI[a]	0	0	0	0	0	63	0	122	0	130	0	152	0	0	0	115	0	120	0	122	0	0
PADDY WATER ENVIRON	33	0	34	0	46	0	36	36	39	39	44	44	31	31	56	56	70	70	51	51	47	47
REV BRAS ENG AGR AMB	0	0	0	0	0	0	0	0	179	179	180	180	180	180	180	180	194	194	180	180	180	180
T ASABE	206	206	244	244	218	218	211	211	188	188	232	232	220	220	202	202	165	165	154	154	203	203
Totals	**1225**	**1222**	**1448**	**1451**	**2315**	**2381**	**2251**	**2423**	**2883**	**3050**	**3486**	**3638**	**3335**	**3335**	**4389**	**4504**	**3632**	**3752**	**3956**	**4078**	**3914**	**4025**

Note: [a-] The data for *Appl Biol Chem* and the *J Korean Soc Appl Bi* is included in Figure B.2 (but not in Figure 2); see Table B.1 for additional information regarding this journal (*Appl Biol Chem* is the updated name for *J Korean Soc Appl Bi*).

Appendix E. JCR citation data for selected journals indexed in the AE journal category (supporting information for data in Tables D.1).

Tables E.2 and E.3 provide citation data, obtained from the overall 2017 JCR data, that list the specific number of citations for two categories: Cited Journal Data and Citing Journal Data[101,102]. These two categories are described as follows:

1) Cited Journal Data: The number of citations that a journal received in a specific year, which includes the aggregate number of citations that the journal receives from all journals (identified as "all" in the top rows of Tables E.2 and E.3) and the number of citations the journal receives from other specific journals.

2) Citing Journal Data: The number of citations that occur from articles published in a journal to other journals in a specific year, which includes the aggregate number of citations that occur from the journal to all other journals (identified as "all" in the top rows of Tables E.2 and E.3) and the number of citations that occur from the journal to other specific journals.

A ranking is included with the journals shown in Tables E.2 and E.3, which is based on the total number of citations that occurred for that respective journal in either the Cited Journal Data or Citing Journal Data categories. These citations are based on the "all years" column for the Cited Journal Data or Citing Journal Data, which includes data extending back from 2016 for over a decade (specific citation data is shown for both categories in the JCR for the 10 years between 2016 and 2007). A common occurrence for both categories are journals with the same number of citations; e.g., there are dozens of journals listed within the Cited Journal Data category which are listed as having provided two citations each to articles that were published in *Bioresource Tech* in 2016. In these situations, the rankings are based on alphabetical order, resulting in journals credited with the same number of citations that are ranked at different levels (e.g., see the *Int J Agr Biol Eng* data columns in Table E.3). These "citation ties" also affect the relative rankings of journals below where the ties occurred in either the Cited Journal Data or Citing Journal Data column. One other odd citation quirk is the fact that citation data is sometimes reported more than once for a specific journal, due to a journal name change or a change in journal abbreviation within the JCR. Citation data affected by multiple name occurrences are indicated via footnotes in Tables E.2 and E.3.

The citation data listed in Table E.2 date was obtained from the 2017 JCR for *Bioresource Technol*, *Ind Crop Prod* and *Biomass Bioenerg*, to allow evaluation of citation patterns between those three journals and to four key comprehensive AE journals: *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*. The citation data in Table E.3 date was obtained for *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*, to support evaluation of citation patterns between those four journals, the remaining JCR AE journals (Table 1) and the journals listed in Table E.1. The additional journals shown in Table E.1 were included due to discernible patterns of relatively strong citation relationships between those journals and *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*. The JCR AE category journals are shown in bold text in Table E.3.

Table E.1 Additional journals included in Table E.3, for comparisons of citation patterns between *Appl Eng Agric*, *Biosyst Eng*, *Int J Agr Biol Eng* and *T ASABE*, and the other nine journals included in the 2017 JCR AE category

Full journal title	Abbreviated journal title	Publisher (country)	Publication Frequency	JCR categories
Agricultural Water Management	Agr Water Manage	Elsevier B.V. (The Netherlands)	Monthly to < monthly	Agronomy; Water Resources
Computers and Electronics in Agriculture	Comput Electron Agr	Elsevier B.V. (The Netherlands)	Monthly to < monthly	Agriculture, Multidisciplinary; Computer Science, Interdisciplinary Applications
Irrigation Science	Irrigation Sci	Springer Verlag (Germany)	Bimonthly	Agronomy; Water Resources
Journal of Environmental Quality	J Environ Qual	ASA, CSSA and SSSA[a]	Bimonthly	Environmental Sciences
Journal of Food Engineering	J Food Eng	Elsevier B.V. (The Netherlands)	Biweekly	Engineering, Chemical; Food Science and Technology
Journal of Soil and Water Conservation	J Soil Water Conser	Soil and Water Conservation Society	Bimonthly	Ecology; Soil Science; Water Resources
Precision Agriculture	Precis Agric	Springer Verlag (Germany)	Bimonthly	Agriculture, Multidisciplinary
Soil Science Society of America Journal	Soil Sci Soc Am J	Soil Science Society of America	Bimonthly	Soil Science

Note: [a] ASA = American Society of Agronomy; CSSA = Crop Science Society of America; SSSA = Soil Science Society of America.

Table E.2 Key Cited Journal Data and Citing Journal Data, for Bioresource Technol, Biomass Bioenerg and Ind Crop Prod, in relation to each other and four primary comprehensive AE journals: Appl Eng Agric, Biosyst Eng, Int J Agr Biol Eng and T ASABE

Bioresource Technol				Biomass Bioenerg				Ind Crop Prod			
Cited Journal Data		Citing Journal Data		Cited Journal Data		Citing Journal Data		Cited Journal Data		Citing Journal Data	
Journal (rank)	Citations	Journal (rank)	Citations	Journal (rank)	Citations	Journal (rank)	Citations	Journal (rank)	Citations	Journal (rank)	Citations
All journals[a]	93 612	All journals	55 413	All journals	18 312	All Journals	14 125	All Journals	15 116	All Journals	31 235
Bioresource Tech (1)	11 644	Bioresource Tech (1)	11 644	Biomass Bioenerg (2)	994	Bioresource Tech (1)	1016	Ind Crop Prod (1)	1609	Ind Crop Prod (1)	1609
Biomass Bioenerg (12)	1016	Biomass Bioenerg (7)	791	Bioresource Tech (3)	791	Biomass Bioenerg (2)	994	Bioresource Tech (4)	273	Bioresource Tech (2)	872
Ind Crop Prod (20)	872	Ind Crop Prod (34)	273	Ind Crop Prod (14)	297	Ind Crop Prod (17)	91	Biomass Bioenerg (19)	91	Biomass Bioenerg (9)	247
T ASABE (173)	80	T ASABE (182)	36	T ASABE (87)	33	Biosyst Eng (83)	21	T ASABE (188)	17	T ASABE (225)	22
Int J Agr Biol Eng (255)	45	Biosyst Eng (194)	31	Biosyst Eng (156)	19	T ASABE (93)	20	Biosyst Eng (215)	14	Biosyst Eng (328)	13
Biosyst Eng (283)	38	Int J Agr Biol Eng (475)	8	Int J Agr Biol Eng (224)	13	Appl Eng Agric (107)	16	Int J Agr Biol Eng (257)	12	Appl Eng Agric (383)	11
Appl Eng Agric (488)	19	Appl Eng Agric (558)	6	Appl Eng Agric (490)	4	Int J Agr Biol Eng (469)	3	Appl Eng Agric (419)	6	Int J Agr Biol Eng (394)	11

Note: [a] The "All Journals" citations are the total citations to the journal of interest (cited journal data) or total citations from the journal of interest (citing journal data) across all of the journals and all of the years that are recorded in the JCR database.

Table E.3 Key Cited Journal Data and Citing Journal Data, for Appl Eng Agric, Biosyst Eng, Int J Agr Biol Eng and T ASABE, in relation to the top ten journals and other JCR AE category journals

Appl Eng Agric				Biosyst Eng				Int J Agr Biol Eng				T ASABE			
Cited Journal Data		Citing Journal Data		Cited Journal Data		Citing Journal Data		Cited Journal Data		Citing Journal Data		Cited Journal Data		Citing Journal Data	
Journal (rank)	Cites[a]	Journal (rank)	Cites	Journal (rank)	Cites	Journal (rank)	Cites	Journal (rank)	Cites	Journal (rank)	Cites	Journal (rank)	Cites	Journal (rank)	Cites
All[b]	1,590	All	3,113	All	4,495	All	7,621	All	503	All	4,106	All	8,412	All	7,705
T ASABE (1)	**164**	**T ASABE (1)**	**187**	**Biosyst Eng (1)**	**456**	**Biosyst Eng (1)**	**564[c]**	**Int J Agr Biol Eng (1)**	**116**	**Int J Agr Biol Eng (2)**	**124[c]**	**T ASABE (1)**	**612**	**T ASABE (1)**	**612**
Appl Eng Agric (2)	**107**	**Appl Eng Agric (2)**	**107**	Comput Electron Agr (2)	226	Comput Electron Agr (2)	303[c]	**T ASABE (3)**	**11**	**Biosyst Eng (3)**	**111[c]**	Agr Water Manage (2)	271	**Appl Eng Agric (2)**	**171[c]**
Comput Electron Agr (3)	53	**Biosyst Eng (3)**	**75[c]**	**Int J Agr Biol Eng (4)**	**87**	**T ASABE (3)**	**241**	**Bio-resource Tech (4)**	**8**	Comput Electron Agr (7)	77[c]	Comput Electron Agr (3)	267	**Biosyst Eng (8)**	**142[c]**
Biosyst Eng (4)	**52**	Soil Sci Soc Am J (4)	43	**T ASABE (5)**	**84**	J Food Eng (4)	126	Comput Electron Agr (5)	8	**T ASABE (8)**	**64**	**Biosyst Eng (5)**	**241**	Agr Water Manage (4)	105
J Environ Qual (5)	38	J Environ Qual (5)	42	J Food Eng (6)	63	**Appl Eng Agric (10)**	**52**	**Appl Eng Agric (9)**	**4**	Agr Water Manage (9)	55	**Appl Eng Agric (6)**	**187**	Comput Electron Agr (6)	89
Agr Water Manage (6)	37	**J Irrig Drain Eng (7)**	**32**	**Appl Eng Agric (8)**	**50**	Precis Agric (12)	45	**Biosyst Eng (10)**	**4**	J Food Eng (10)	51	**J Irrig Drain Eng (11)**	**123**	J Food Eng (7)	87
Int J Agr Biol Eng (7)	**26**	Agr Water Manage (8)	31	Agr Water Manage (8)	31	Soil Sci Soc Am J (14)	42	**Ind Crop Prod (15)**	**4**	**Bio-resource Tech (11)**	**45**	J Environ Qual (12)	117	**Biosyst Eng (8)**	**84**
Biomass Bioenerg (9)	**16**	Comp Electron Agr (11)	29	**Bio-resource Tech (19)**	**31**	**Bio-resourc e Tech (18)**	**38**	Agr Water Manage (20)	3	**Appl Eng Agric (15)**	**26**	**Int J Agr Biol Eng (18)**	**64**	J Environ Qual (9)	81
J Irrig Drain Eng (17)	16	J Food Eng (15)	24	J Environ Qual (21)	30	Agr Water Manage (25)	29	**Biomass Bioenerg (22)**	**3**	Irrigation Sci (26)	17	Soil Sci Soc Am J (24)	52	**Bio-resource Tech (10)**	**80**
Ind Crop Prod (20)	**11**	**Bio-resource Tech (20)**	**19**	**Biomass Bioenerg (36)**	**21**	**J Irrig Drain Eng (37)**	**21**	J Food Eng (29)	3	**J Irrig Drain Eng (25)**	**16**	J Food Eng (30)	45	Soil Sci Soc Am J (12)	71
AMA-Agr Mech Asia AF (30)	**8**	Precis Agric (29)	12	Precis Agric (39)	17	**Biomass Bioenerg (45)**	**19**			Soil Sci Soc Am J (26)	16	J Soil Water Conserv (34)	10	Irrigation Sci (18)	49
Bio-resource Technol (47)	**6**	J Soil Water Conserv (34)	10	**Eng Agr-Jabotical (49)**	**17**	Irrigation Sci (53)	6			**Biomass Bioenerg (31)**	**13**	**Bio-resour ce Tech (37)**	**36**	**J Irrig Drain Eng (20)**	**46**
Irrigation Sci (53)	6	Irrigation Sci (40)	9	**Ind Crop Prod (67)**	**13**	**Ind Crop Prod (57)**	**14**			**AMA-Agr Mech Asia AF (35)**	**12**	J Soil Water Conserv (34)	10	**Biomass Bioenerg (24)**	**33**
Precis Agric (56)	6	**Ind Crop Prod (65)**	**6**	**Rev Bras Eng Agr Amb (69)**	**13**	J Environ Qual (67)	13			**Ind Crop Prod (37)**	**12**	**Bio-resour ce Tech (37)**	**36**	J Soil Water Conserv (25)	33
J Food Eng (67)	5	**Rev Bras Eng Agr Amb (84)**	**5**	**J Irrig Drain Eng (80)**	**11**	**Int J Agr Biol Eng (245)**	**4**			**Eng Agr-Jabotical (312)**	**2**	Irrigation Sci (38)	36	**Aquacult Eng (49)**	**18**
J Soil Water Conserv (71)	5	**Biomass Bioenerg (87)**	**4**	Soil Sci Soc Am J (84)	11	J Soil Water Conserv (34)	10			J Soil Water Conserv (372)	4[c]	**AMA-Agr Mech Asia AF (53)**	**25**	**Ind Crop Prod (56)**	**17**
Rev Bras Eng Agr Amb (90)	**4**	**Int J Agr Biol Eng (93)**	**4**	**AMA-Agr Mech Asia AF (87)**	**10**	**AMA-Agr Mech Asia AF (445)**	**2**			**Paddy Water Environ (393)**	**2**	**Ind Crop Prod (66)**	**22**	Precis Agric (75)	13
Eng Agr-Jabotical (106)	**3**	**AMA-Agr Mech Asia AF (112)**	**3**	Irrigation Sci (105)	9	**Aquacult Eng (457)**	**2**					**Rev Bras Eng Agr Amb (72)**	**21**	**Int J Agr Biol Eng (86)**	**11**
Aquacult Eng (136)	**2**			**Paddy Water Environ (294)**	3							**Biomass Bioenerg (74)**	**20**	**Rev Bras Eng Agr Amb (273)**	**4**
												Eng Agr-Jabotical (94)	**17**	**Eng Agr-Jabotical (494)**	**2**
												Precis Agric (56)	6		

Note: [a] cites = citations

[b] The "All" citations are the total citations to the journal of interest (cited journal data) or total citations from the journal of interest (citing journal data) across all of the journals and all of the years that are recorded in the JCR database.

[c] Several of the citation values in Table E.3 represent combinations of two different citation amounts recorded for the same journal, due to some of the citations being recorded for a previous name of an existing journal (e.g., *J Agr Eng Res* was the previous name of *Biosyst Eng*) or due to a change in the abbreviation used for a journal name in the JCR (also discussed in further detail in Appendix D). The specific Table E.3 citation values that were affected by these changes are described as a function of a specific data column:

Appl Eng Agr/Citing Journal Data: 75 cites (Biosyst Eng) = 50 cites (Biosyst Eng) + 25 cites (J Agr Eng Res)

Biosyst Eng/Citing Journal Data: 564 cites (Biosyst Eng) = 456 cites (Biosyst Eng) + 108 cites (J Agr Eng Res)

Biosyst Eng/Citing Journal Data: 303 cites (Comput Electron Agr) = 281 cites (Comput Electron Agr) + 22 cites (Computers Elect Agr)

Int J Agr Biol Eng/Citing Journal Data: 124 cites (Int J Agr Biol Eng) = 116 cites (Int J Agr Biol Eng) + 8 cites (Int J Agric Biol Eng)

Int J Agr Biol Eng/Citing Journal Data: 111 cites (Biosyst Eng) = 87 cites (Biosyst Eng) + 24 cites (J Agr Eng Res)

Int J Agr Biol Eng/Citing Journal Data: 77 cites (Comput Electron Agr) = 64 cites (Comput Electron Agr) + 13 cites (Computers Elect Agr)

Int J Agr Biol Eng/Citing Journal Data: 4 cites (J Soil Water Conserv) = 2 cites (J Soil Water Conserv) + 2 cites (J Soils Water Conser)

T ASABE/Citing Journal Data: 171 cites (Appl Eng Agr) = 164 cites (Appl Eng Agr) + 7 (Appl Eng Agr in press)

T ASABE/Citing Journal Data: 142 cites (Biosyst Eng) = 84 cites (Biosyst Eng) + 58 cites (J Agr Eng Res)