LWT - Food Science and Technology 67 (2016) 133–142

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Atlas of scientific institutions in food science (Scopus, 2003–2013)

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ARTICLE INFO

Article history:
Received 30 October 2015
Received in revised form
14 November 2015
Accepted 19 November 2015
Available online 23 November 2015

Keywords:
Food science
Citation analysis
Bibliometric
Research activity
Networks

ABSTRACT

Bibliometric indicators are used to characterize the research activity of institutions worldwide with production in the period 2003–2013 in journals that are indexed in Scopus's Food Science thematic category. Basic, normalized indicators were used to compare the institutions' performances, together with highly cited papers (top-10% and top-1%). An interactive map was generated, displaying the 645 institutions with at least 100 documents produced during this period. The greatest numbers of those institutions are in the United States, South Korea, Spain, and China. National collaboration networks were detected on the East and West Coasts of the United States, and in Canada, Ireland, France, Spain, Holland, Denmark, China, South Korea, Malaysia, Brazil, India, Argentina, and Nigeria. There was no significant research activity in many developing and food exporting countries located in sub-Saharan Africa, North and East Africa, the Middle East, Latin America, the Caribbean, Eastern Europe, Central Asia, and South East Asia. The need to take into account other criteria based on qualitative attributes and the inherent limitations in the bibliometric indicators are discussed.

1. Introduction

The world's population has now surpassed seven billion people. Current projections estimate that by 2030 there will be 8.5 billion, and that by 2050 there will be 9.7 billion (United Nations, 2015). This demographic development goes together with dietary changes, increased demand for food, improvements in crop and livestock farming, and the consequent increase in food production, although there will persist problems of malnutrition, food safety, and threats to biodiversity.

Food Science (FS) is a multidisciplinary field of research intertwining chemistry, biochemistry, nutrition, microbiology, and engineering. According to the classification scheme of scientific fields used in the AgriMapping project, FS comprises eleven broad thematic areas in the first level of aggregation, and forty-one that are more specific in the second level (Borsi & Schubert, 2011). This applied science character, aimed at solving complex, transdisciplinary, inter-institutional, cross-border problems, oriented towards quality control, and with a high level of social responsibility, means that its research practices fall under the so-called Mode 2 production of knowledge (Nowotny, Scott, & Gibbons, 2003).

The present study applies one of the possibilities offered by bibliometric methods (Guerrero-Bote & Moya-Anegón, 2015) to analyse the scientific production worldwide in FS at an institutional level. A characteristic of Mode 2 production of knowledge is that the resolution of the problems it deals with requires collaborative work of teams made up of people with different skills and experiences.

Institutionally, this means that there are many more potential places where such knowledge can be created (Hoekman, Frenken, & Tijssen, 2010). As well as universities, Mode 2 knowledge production will typically involve the interaction of research centres and institutes, governmental organizations, industry laboratories, and business firms, and from different regions within a given country or from different countries. With the bibliometric indicators calculated in the present work, the aim is to offer a comprehensive global overview of the scientific results obtained by the most productive institutions that carry out FS research. To this end, we use the basic bibliometric indicators that have been available for decades, relative or normalized indicators that correct some previous biases, and advanced network analysis indicators which express influence or prestige (Moed & Plume, 2011).

Another aspect of the present study is that it takes advantage of

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http://dx.doi.org/10.1016/j.lwt.2015.11.035
0023-6438/

today's graphical visualization techniques to represent spatially certain aspects of the worldwide system of FS production. We consider the links of cooperation between the producing centres, detecting those links through the counts of co-authored papers and adding the impact values of those works. We then analyse different dimensions that those links express: (i) the network's structure as indicated by the sizes of the nodes; (ii) the national dimension of the network as represented by the relationships of interconnection between centres of the same country; and (iii) the international dimension as determined from the co-authorship relationships. Finally, we shall colour-code the links according to their impact values to facilitate the exploration of the resulting topology and the identification of paths in the network. To this end, we shall overlay the inter-institutional network on a Google map of the world. Studies taking a similar methodological approach have been carried out on, for example, the thematic category of Library and Information Sciences worldwide (Leydesdorff & Persson, 2010), on the highly cited papers produced in European cities on Neuroscience, Social Sciences, Astronomy, and Physics (Bornmann, Leydesdorff, Walch-Solimena, & Ettl, 2011), and on international collaboration between countries worldwide (Leydesdorff, Wagner, Park, & Adams, 2013).

2. Material and methods

The empirical material used in this study is based on original data of the Scopus multidisciplinary index (http://www.elsevier.com/solutions/scopus) compiled for the SCImago Institution Ranking (SIR) database (http://www.scimagoir.com). Scopus is the abstract and citation database of peer-reviewed literature with the broadest coverage. It is published by Elsevier. The SIR database includes bibliometric indicators of 4289 research centres worldwide (August 2015), including universities and research institutes, that published at least 100 documents during 2013. Together, these centres account for more than 80% of the world's scientific production indexed by the Scopus database.

SIR's thematic classification follows the Scopus conventions, classifying the journals into 27 major thematic categories (Subject Areas) and 313 minor, more restricted, thematic categories (Specific Subject Areas or Categories). The Subject Area of Agriculture and Biological Sciences comprises 11 Specific Subject Areas. One of these is Food Science, which, in 2013, included 234 journal titles.

For the purposes described above, we downloaded all the documents published in those journals in the period 2003–2013.

The bibliometric indicators calculated to characterize the scientific production in FS of each of those institutions were the following:

- *Ndoc*: Number of documents published in scientific journals included in the Scopus database.
- *%Ndoc*: Percentage of the documents concerning an area or category (here Food Science) with respect to the total production of the institution in question.
- *% International Collaboration*: Percentage of the documents in whose byline there appear authors of various countries. The "whole counting" method was used, following the procedures by which Scopus obtained and assigned the personal addresses contained in the publications in its database. If there were two different institutions signing the publications, the two institution names were used to subsequently add to them the geographic coordinates of latitude and longitude.
- *RG*: Number of documents published in scientific journals indexed in Scopus in which an author of the corresponding institution acted as Research Guarantor (corresponding author) (Moya-Anegón, Guerrero-Bote, Bornmann, & Moed, 2013). This indicator is also expressed as a percentage (%RG).
- *Normalized Impact (NI)*: Average normalized citation received by each document. This is understood as being the ratio between the citation received by the document and the average citation of documents of the same type, year, and category (Rehn & Kronman, 2008).
- *Excellence10*: Number of documents that are among the 10% most cited of the same year, type, and category (Bornmann, Moya-Anegón, & Leydesdorff, 2012). The indicator is also expressed as a percentage (%Excellence10).
- *Excellence10 as RG*: Number of documents that are among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author). The indicator is also expressed as a percentage (%Excellence10 as RG).
- *Excellence1*: Number of documents that are among the 1% most cited of the same year, type, and category. The indicator is also expressed as a percentage (%Excellence1).

We analysed the distribution of the indicators *%Excellence10 as RG* and *%Excellence1* of the institutions classified into 42 classes: a "total" class, with the values of all the institutions included in the study; four classes of institutions classified by activity sector; eight classes by continent; and twenty-nine classes by country. For these two indicators of excellence, we calculated the 25th, 50th, and 75th percentiles for each class of institution. Outliers were determined using the interquartile range method. The results are presented as box-and-whisker plots. This approach, based on percentile ranges, is interpreted as providing quality values because it takes into consideration the underlying form of the distribution of the citations within the thematic category. The advantage of using rankings based on percentiles is that it allows one to compare the citation distributions of uneven sets of documents, as is the case with institutional productions in FS (Leydesdorff, Bornmann, Mutz, & Opthof, 2011). To assist in better understanding the performance of the institutions, Table A1 in Appendix A presents other results of interest of the great amount of data used.

Geolocation using the place or institution names listed in the addresses of research papers, as in the present case, allows the places where this knowledge has been created, and whence it is being disseminated, to be located (Frenken, Hardeman, & Hoekman, 2009). The names and locations of the institutions that appear in the byline of the document's address field were extracted after normalization with manual and semi-automatic procedures. To generate the map, we used the GPS Visualizer online utility, accessible gratis at http://www.gpsvisualizer.com/. Besides giving this utility the institution's coordinates (latitude and longitude), we also input to it a series of bibliometric data for representation and consultation. The provider of the geographic coordinates was Google.

3. Results and discussion

The downloaded data were 201 220 documents of all types. Of these, 90% were articles, 5% reviews, 2% conference papers, 1% editorials, and the remaining 2% other documents. In order to discard the participating institutions which just have an occasional production on FS, we kept only those that produced 100 or more works in the period studied. This left a total of 645 different institutions worldwide. Of these, 84% were higher education institutions, 13% public research institutes, 2% health institutions, and 1% private entities.

The plots of Figs. 1 and 2 show the rankings of the 645 institutions using different indicators: production-size dependent

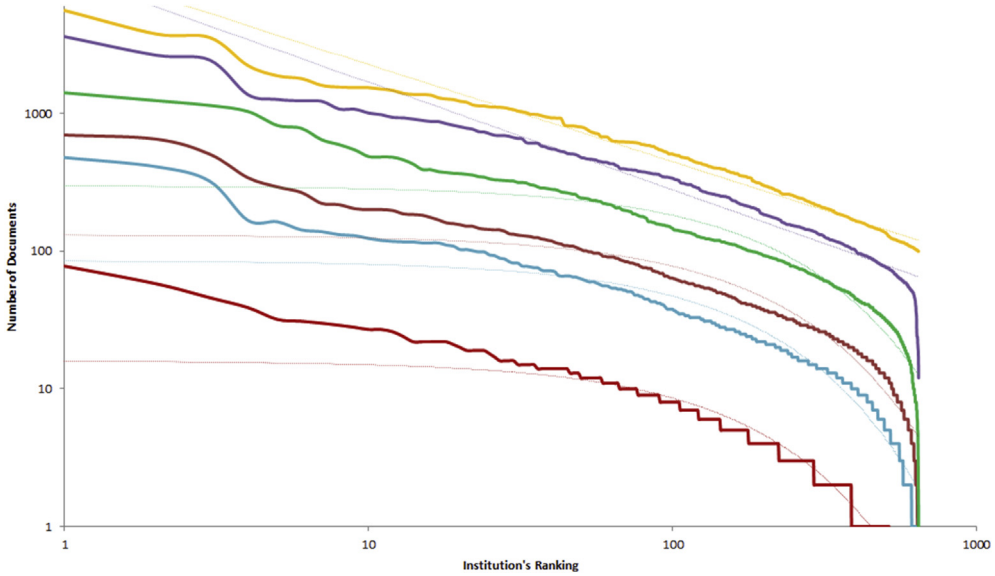

Fig. 1. Superposition of the values of the total production (*Ndoc*) (*best trend line*: $y = 11645x^{-0.708}$; $R^2 = 0.9709$), total production as *Research Guarantor* (*RG*) (*best trend line*: $y = 10229x^{-0.782}$; $R^2 = 0.9191$), total production with international collaboration (*best trend line*: $y = 297.98e^{-0.005x}$; $R^2 = 0.9159$), excellence as belonging to the 10% most cited documents of the same type (*Excellence10*) (*best trend line*: $y = 131.37e^{-0.005x}$; $R^2 = 0.9283$), the same but also as *Research Guarantor* (*Excellence10 as RG*) (*best trend line*: $y = 85.136e^{-0.006x}$; $R^2 = 0.9447$), and excellence as belonging to the 1% most cited documents of the same type (*Excellence1*) (*best trend line*: $y = 15.887e^{-0.006x}$; $R^2 = 0.943$) versus the institution's ranking.

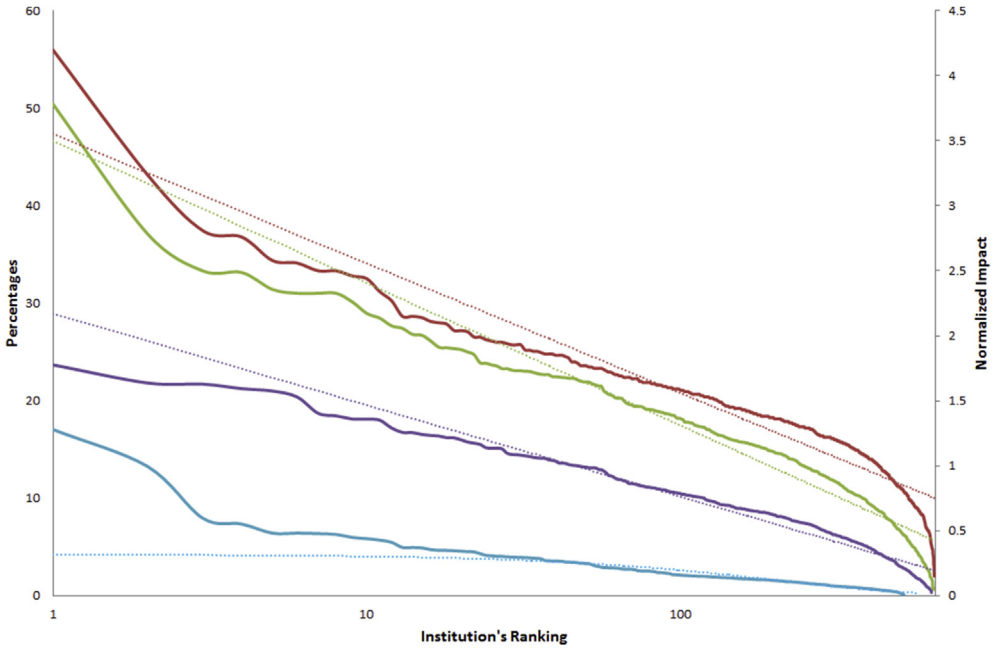

Fig. 2. Superposition of the *Normalized Impact* (*best trend line*: $y = -0.433\ln(x) + 3.5546$; $R^2 = 0.9007$), and the percentage values of excellence as belonging to the 10% most cited documents of the same type (*%Excellence10*) (*best trend line*: $y = -6.343\ln(x) + 46.672$; $R^2 = 0.9319$), the same but also as *Research Guarantor* (*%Excellence10 as RG*) (*best trend line*: $y = -4.076\ln(x) + 28.935$; $R^2 = 0.9519$), and excellence as belonging to the 1% most cited documents of the same type (*%Excellence1*) (*best trend line*: $y = 4.2244e^{-0.005x}$; $R^2 = 0.9379$), versus the institution's ranking.

indicators were used in Fig. 1, and research-performance dependent indicators in Fig. 2. The indicator most strongly correlated with *Ndoc* is *RG* ($R = 0.98$), followed by the absolute values of *Excellence10* (R = 0.93), *Excellence10 as RG* (R = 0.91), and *Excellence1* ($R = 0.82$). The percentage of international collaboration is poorly correlated with *Ndoc* ($R = 0.00$), with the *NI* ($R = 0.42$), and with the other indicators of excellence. Consequently, in FS, collaboration with foreign partners either did not contribute to achieving a greater impact or good foreign partners were not chosen. The three excellence-based indicators are at a level below that of the other three indicators. The mean value of *Ndoc* ($x = 332$; s.d. = 2757.5; SEM = 108.5), is 8 times greater than the mean of *Excellence10* ($x = 40$; s.d. = 3489; SEM = 13.7), 14 times greater than the mean of *Excellence10 as RG* ($x = 23$; s.d. = 205; SEM = 8.0), and 79 times greater than the mean of the absolute values of *Excellence1* ($x = 4$; s.d. = 38; SEM = 1.4). The distributions of the size dependent

indicators fit a power law (r^2>0.91), although the final fall is exponential, as shown in Fig. 1. There is no such fall in *Ndoc* because it was the indicator used to set the threshold.

Fig. 2 shows the values of the performance of the world's elite in FS research. The *NI* and *%Excellence10* indicators are strongly correlated ($R = 0.92$). The values fall more sharply in the first group of institutions (1–10) than in the next group (11–100). In other words, there are greater differences in performance among the top-ten ranked institutions worldwide as measured with the two indicators of normalized impact and 90th percentile than among the following, more homogeneous, group of institutions. The fall fits a process of logarithmic decline.

Fig. 3 shows the box-and-whisker plot of the RG values of the 645 institutions with production in Food Science. Noteworthy are the productions of Denmark, Belgium, Ireland, United States, and Malaysia.

Comparisons of the institutional performances by continent, sector, and country are presented in the box-and-whisker plots of Figs. 4 and 5 and in the set of tables of Appendix A.

Fig. 4 shows these institutional performance comparisons as reflected in the values of the *%Excellence10 as RG* indicator. By sector, the performance is very uneven because of the existence of centres with extreme performances in both directions, especially in higher education institutions in the United States and Canada. By continent, the mean performances of the European (8.5%), North American (8.2%), and Pacific (7.0%) institutions are greater than those of Asia (4.8%), Latin America (3.8%), Middle East (6.1%), Eastern Europe (4.3%), and Africa (2.8%). Western Europe has the greatest institutional base in terms of the number of most active institutions in publication in the Specific Subject Area – 32% of the institutions in the study. It is followed by Asia (24%) and North America (15%).

The average of *Excellence10 as RG* of research studies ascribed to the United States is below that of such Western European countries as Greece (11.2%), Ireland (11.1%), Belgium (10.4%), Spain (10%), and Portugal (9.6%) or, in the Middle East, Israel (10.6%). The interval occupied by the fourth quartile of Europe is larger than that of North America, whose first quartile, however, occupies a greater interval, as well as having a greater interquartile range. Therefore, the existence of outliers makes us unable to draw any definite conclusions in this first analysis. In Asia, there stand out China (6.5%) and India (6.4%). Taiwan has values of the median above those of Asia overall, and an uneven distribution of centres towards those of better performance. In this sense, its distribution is similar to that of Thailand. South Korea and Japan do not reach the mean value of Asia. New Zealand's institutions (7.6%) are more productive in this sense of excellence than those of Australia (6.7%), and are more homogeneous. In Latin America, the impact of research in Chile (7.9%) is greater than that in Argentina (5.2%), Mexico (4.2%), and Brazil (3.1%). In the Middle East, Turkey and Iran have similar values of the median and the mean, but below those of China and India.

Fig. 5 presents the comparison of the research performances of the institutions classified by activity sector, continent, and country based on the 99th percentile of most cited papers, i.e., of the *% Excellence1* indicator. There are many classes of institution whose ratios, medians, and means surpass the totals. By sectors, there stand out those involving private entities such as Nestle, DayriNZ Ltd, and Pfizer, among others. According to this indicator, the top centres (>6%) are the University of Development Alternative (BGD), Oak Ridge National Laboratory (USA), the University of Michigan, Ann Arbor (USA), the Max Planck Gesellschaft (DEU), the Universidade do Minho (PT), the Memorial University of Newfoundland (CAN), and the University of Massachusetts Amherst (USA).

The map in Fig. 6 represents the worldwide network of inter-institutional collaboration involving research institutions which produced at least 100 documents from 2003 to 2013 indexed in the Scopus Specific Subject Area of Food Science. The radius of a disc at a node on the map is proportional to the volume of production, and the thickness of a link is proportional to the volume of co-authored papers between the corresponding institutions. The colours of the nodes and links correspond to the value of the normalized impact of the respective institutions' own production and production in collaboration. The key to the equivalence between impact and colour is in the upper left-hand corner of the map. The collaborative links between institutions that appear in the window at the top right can be used to locate those links on the map and to see the bibliometric indicators related to production in collaboration between institutions (*Ndoc*; *NI*; *%Excellence10*; *%Excellence1*). Also in that window, with the abbreviation of an institution, all of its links can be located by searching with the browser. This is convenient because the thinness of some links makes them invisible. Clicking on one of the discs opens a window displaying all the bibliometric indicators associated with the production of that institution, and similarly for the links if one of them is clicked on.

The interconnection between research centres is an important quality with which to detect areas with high-status centres. With production volume chosen as the criterion for allocating the size of the nodes, certain institutions stand out. For example, Washington, D.C. on the East Coast of the United States houses the United States Department of Agriculture, and Ottawa its Canadian counterpart. Examples in Western Europe are Madrid (Consejo Superior de Investigaciones Científicas), Paris (Centre National de la Recherche Scientifique; Institute Nationale de la Recherche Agronomique), Brussels (Katholieke Universiteit Leuven), Ghent (Ghent University), Wageningen (Wageningen University and Research Centre) in the Netherlands, and Copenhagen (University of Copenhagen). Outside these agglomerations in Europe and North America, other centres stand out for the volume of their production, but not for the value of their normalized impact. Examples are Sao Paulo (Universidade de Sao Paulo), Brasilia (Empresa Brasileira de Pesquisa Agropecuaria), Delhi (Indian Council of Agricultural Research), Buenos Aires (Consejo Nacional de Investigaciones Científicas y Técnicas), and Beijing (China Agricultural University).

Intercontinental links have been frequent between centres of Western Europe and the United States, and between centres of the United States or Canada and three Asian countries (China, South Korea, and Japan). But in this thematic domain, the system of national links between centres is always of greater intensity than links established internationally, reflecting how the effects of geographical proximity, the weight of national regulations, and language constrain international interactions (Katz, 1994; Ponds, van Oort, & Frenken, 2007). Two examples of national networks in Europe are the cluster of Irish centres (University College Dublin – Irish Agriculture and Food Development Authority – University College Cork) and the French radial network, centred in Paris and reaching out to Nantes (Université de Nantes), Dijon (Université de Bourgogne), Bordeaux (Université de Bordeaux), Montpellier (Université Paul Sabatier), and Toulouse (Institut National Polytechnique de Toulouse). Another European national network stands out in Spain, around Madrid (Consejo Superior de Investigaciones Científicas) and its links with Catalonia (Universidad Autónoma de Barcelona), Valencia (Universidad de Valencia), and Seville (Universidad de Sevilla). Similar national networks are distinguishable on the East Coast and in the Great Lakes regions of the United States and Canada, in South Korea with Seoul as the centre, Japan, Malaysia, Australia, and New Zealand. In this sense, the nation-state is still a long way from disappearing, and remains a key unit in the panorama of scientific research in the early twenty-first century.

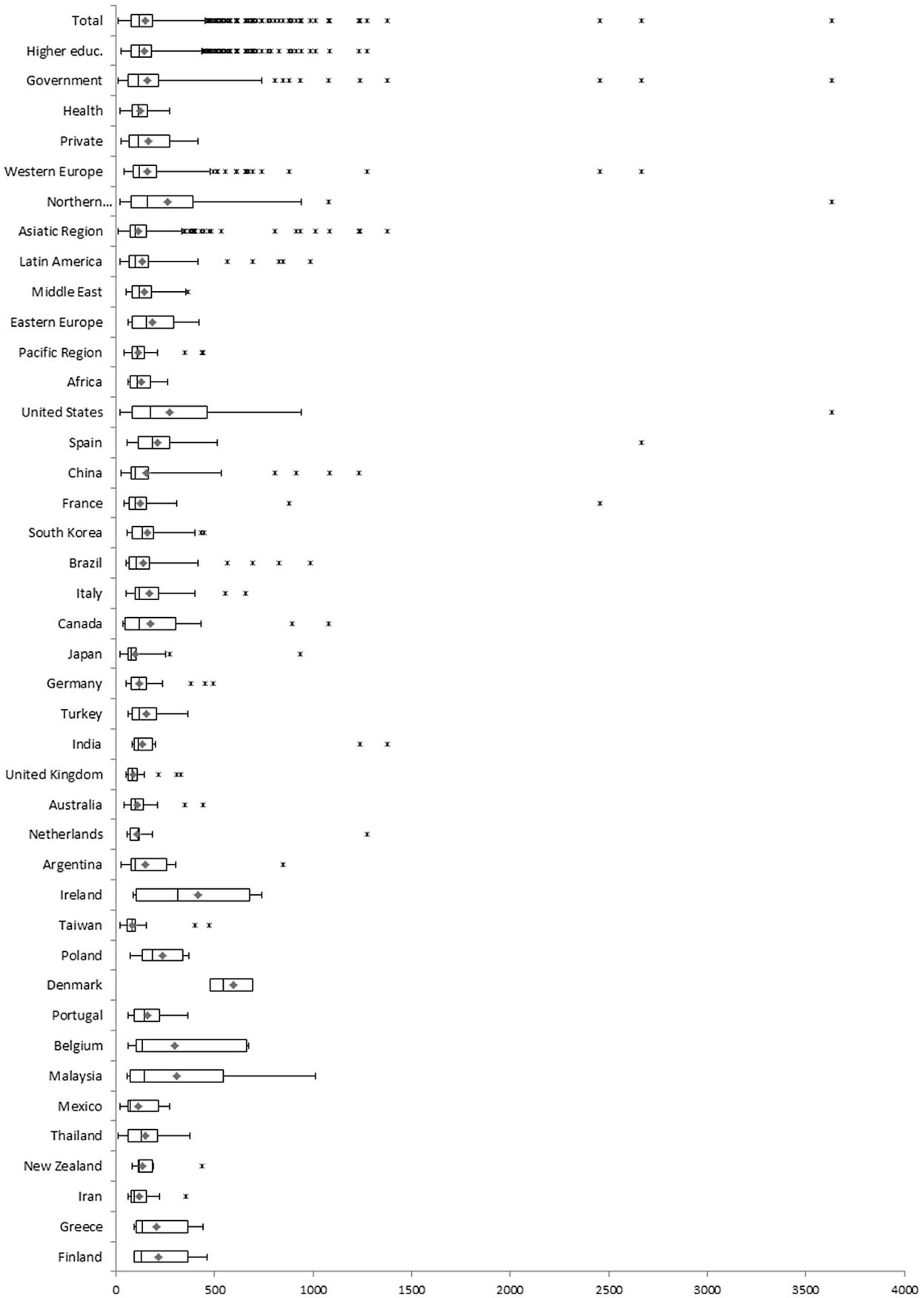

Fig. 3. Box-and-whisker plot of the RG values of the 645 institutions with production in Food Science. Inside the box, the black diamond identifies the arithmetic mean, and the vertical separator the median. The edges of the box indicate the first and third quartiles. The ends of the straight lines (the "whiskers") extending from the box are the minimum and maximum values. Asterisks displayed beyond the ends of the whiskers represent outliers as calculated by the interquartile range method.

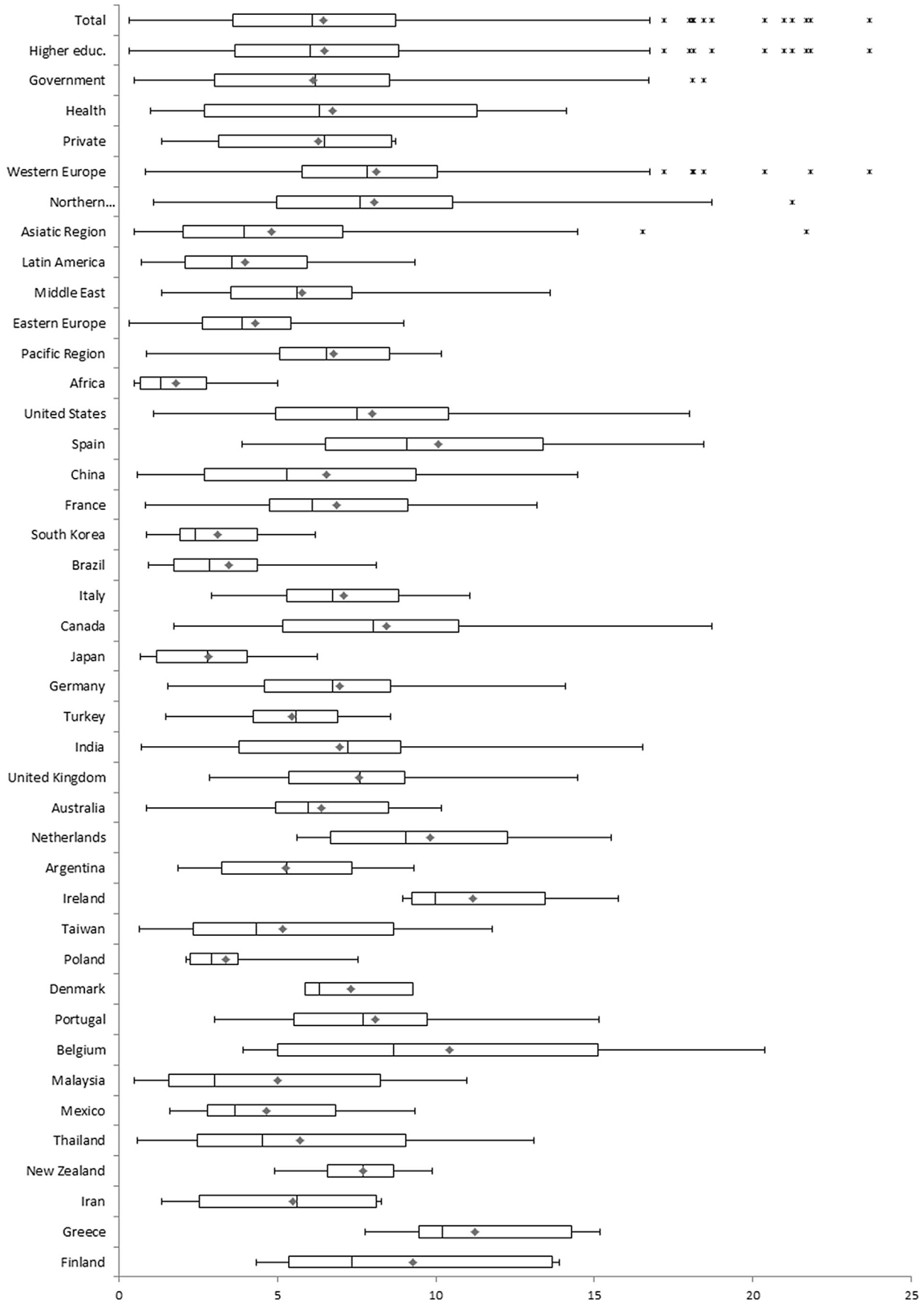

Fig. 4. Box-and-whisker plot of the *%Excellence10 as RG* of the 645 institutions with production in Food Science. Inside the box, the black diamond identifies the arithmetic mean, and the vertical separator the median. The edges of the box indicate the first and third quartiles. The ends of the straight lines (the "whiskers") extending from the box are the minimum and maximum values. Asterisks displayed beyond the ends of the whiskers represent outliers as calculated by the interquartile range method.

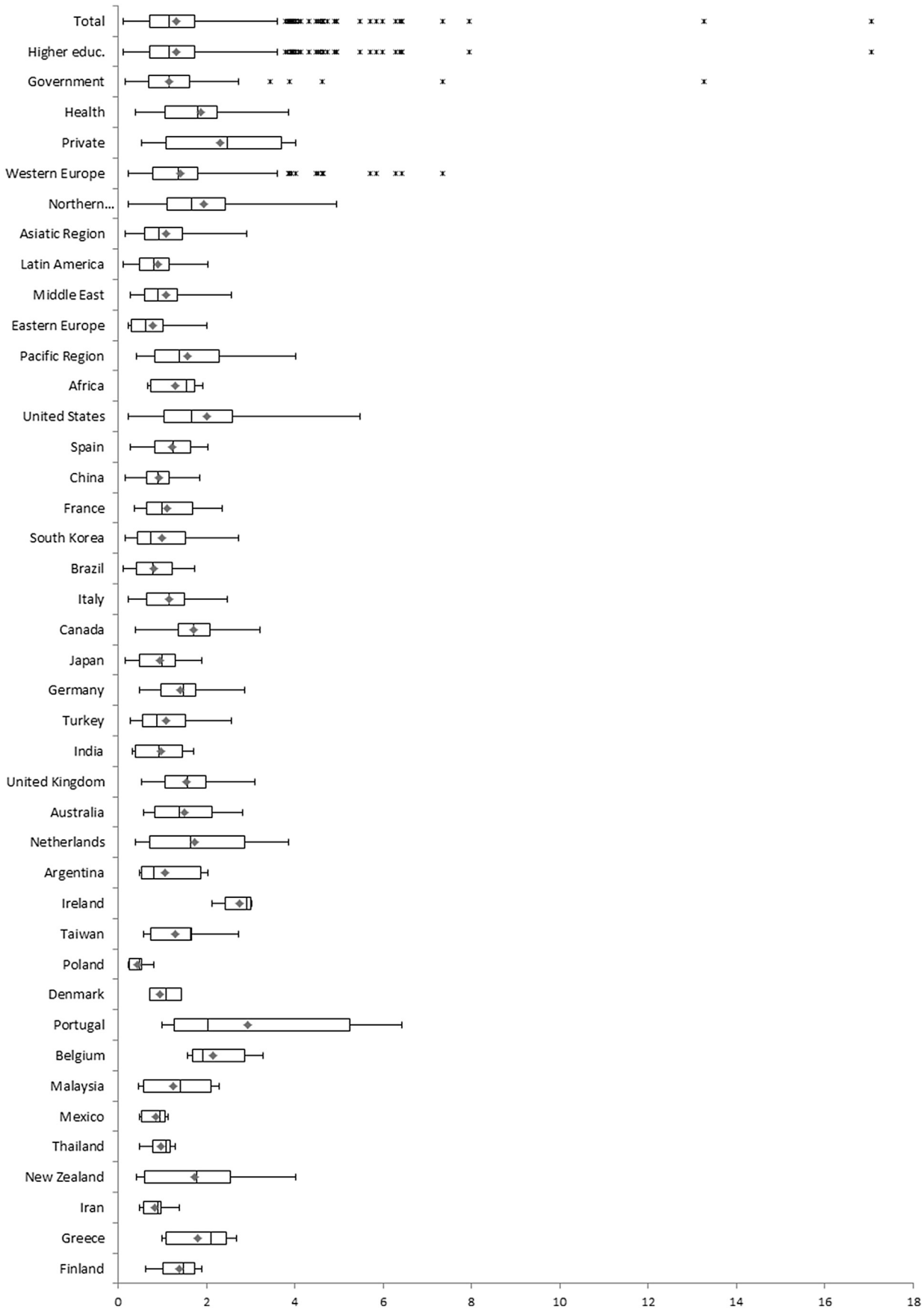

Fig. 5. Box-and-whisker plot of the *%Excellence1* of the 645 institutions with production in Food Science. Inside the box, the black diamond identifies the arithmetic mean, and the vertical separator the median. The edges of the box indicate the first and third quartiles. The ends of the straight lines (the "whiskers") extending from the box are the minimum and maximum values. Asterisks displayed beyond the ends of the whiskers represent outliers as calculated by the interquartile range method.

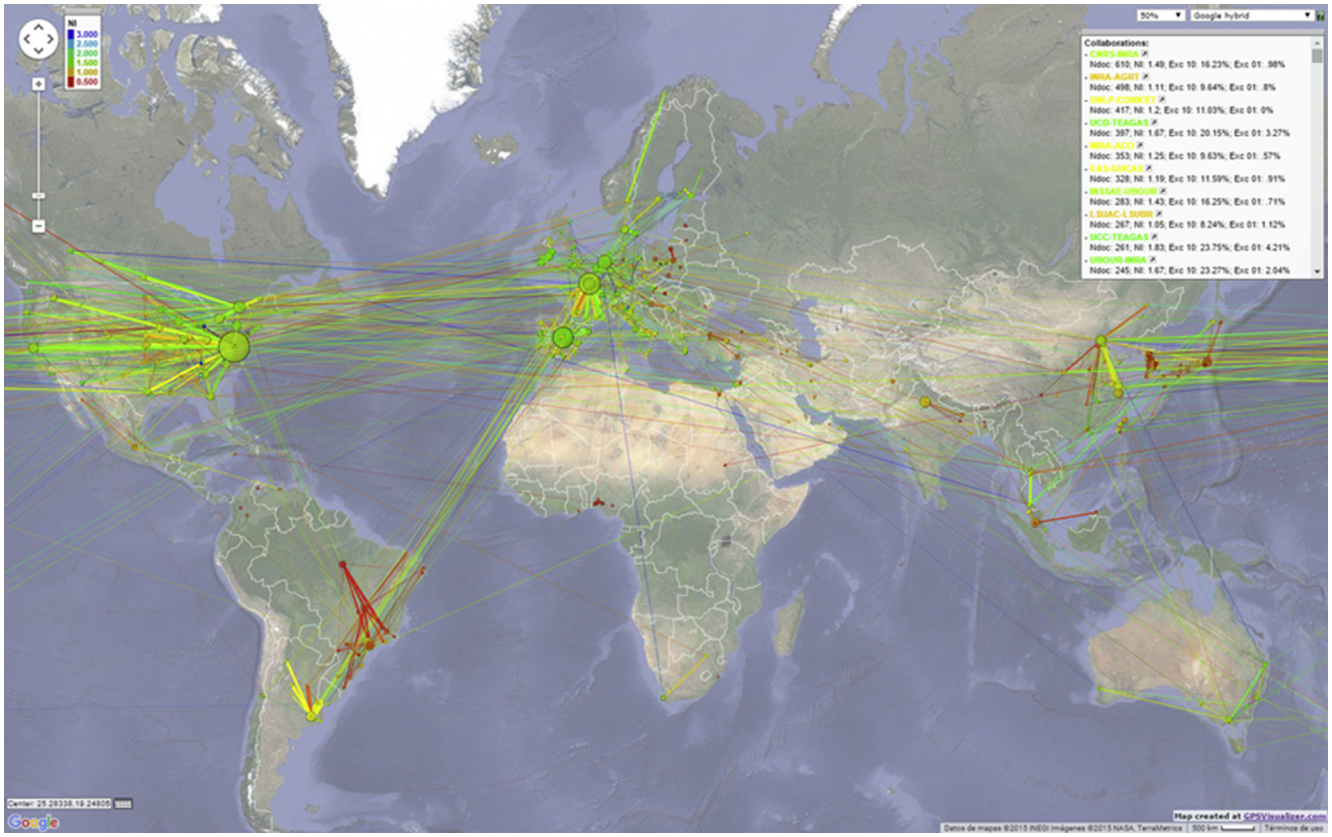

Fig. 6. Global network of inter-institutional collaboration in Food Science from 2003 to 2013 (for institutions with a total production of at least 100 documents, whole counting). An interactive version, with zoom, is accessible at http://tinyurl.com/ojrlnuy. Data source: Scopus.

4. Conclusions

Using various bibliometric indicators of impact, this work has characterized the research performance of 645 institutions worldwide with production in Scopus's Food Science thematic category. These indicators provided a global panorama of this research production. But synthesizing the results of this analysis in a single image was complicated by the large number of active centres and of networks and sub-networks detected through the co-authorship links. The methodological approach taken to contribute to resolving this problem was to generate a map of the institutions that distinguishes nodes whose collaborative work is highly cited and others which simultaneously have high values of both production and impact. The resulting map brings out visually the spatial structure of the distribution of research activities in FS. In accordance with other studies, the analysis confirmed the long-standing dominance in terms of the absolute number of publications and the impact of their citations of important research centres located in Western Europe, the United States, and Canada. Our analysis suggests that worldwide production of scientific knowledge in FS is organized with a clear division between countries of the North and such emerging countries as China, South Korea, Malaysia, India, and Brazil. The national networks that are seen on the map are governed, in the absence of further analysis, by the factor of geographical proximity, an important determinant of interregional collaboration. Online consultation of the map also highlights the hybridization existing in the production of knowledge in this field since it reveals links between research organizations of quite different nature, both within and across national frontiers. Nationally, economic prosperity is clearly correlated with investment in science.

However, there are wide geographical areas in which no notable research activity is detected. These are food-exporting developing countries of Sub-Saharan Africa, North and East Africa, the Middle East, Latin America, the Caribbean, Eastern Europe, Central Asia, and Southeast Asia. The concentration of scientific research in certain countries and geographical areas means not only that they generate more and better knowledge than others, but that they can determine what type of orientation the research is to take and what kind of problems have priority in that research, in particular with institutions that have a worldwide reputation. While institutions of this type play a critical role in ensuring the quality of life in their own countries, the knowledge they possess and create is so specialized and local that it may not be effectively applicable in other regions.

This study has certain limitations. There may have slipped through some visualization error in the automated allocation of the geographic coordinates or classification of the data in the documents' address fields. The bibliometric indicators only take into account the results of the analysis of scientific journals, rejecting other research results which are disseminated through other channels such as patents, or books. Research practices are too complex to be reduced to a set of numbers, so that other relevant aspects of practical research itself are not reflected. However, citations-based indicators are good approximate measures of a publication's impact on research communities, and as such may be used in processes of expert reviews. The results presented here do not prejudge future findings, but they do contribute to the description of the spatial distribution of scientific output in FS at a global, national, regional, and city level.

Acknowledgments

This work was financed by the Junta de Extremadura and the Consejería de Educación Ciencia & Tecnología, and the European Social Fund, as part of research group grant GR15024, and by the Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica 2012–2015 and the European Regional Development Fund (ERDF) as part of research project CSO2013-40530-R.

Appendix B. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.lwt.2015.11.035.

Appendix A

Table A1
Number of institutions, percentages with respect to total, and averages per institution, by sector. Abbreviations: Ins: Number of Institutions, %Ins: Percentage of Institutions, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Ndoc: Percentage of documents, Ndoc: Number of documents, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %IC: Percentage of the documents in whose byline there appear authors of various countries, NI: (Normalized Impact) Average normalized citation received by each document, %Exc10: Percentage of documents among the 10% most cited of the same year, type, and category,%Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc1: Percentage of documents among the 10% most cited of the same year, type, and category.

Sector	Ins.	With respect to total			Averages per institution							
		%Ins	%RG	%Exc10 RG	%Ndoc	Ndoc	%RG	%IC	NI	%Exc10	%Exc10 RG	%Exc1
Higher educ.	540	83.98	77.27	76.35	3.52	302	61.70	28.86	1.17	11.72	6.66	1.27
Government	82	12.75	20.62	21.33	13.62	548	53.58	30.91	1.18	12.29	5.91	1.22
Health	15	2.33	1.38	1.74	7.21	230	51.88	29.56	1.41	15.83	6.74	1.49
Private	6	0.93	0.73	0.58	23.71	361	48.83	38.48	1.33	13.42	5.25	1.92
Total	645	100	100	100	**5.09**	332	60.32	29.24	1.18	11.92	6.56	1.28

Table A2
Number of institutions, percentages with respect to total, and averages per institution, by region. Abbreviations: Ins: Number of Institutions, %Ins: Percentage of Institutions, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Ndoc: Percentage of documents, Ndoc: Number of documents, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %IC: Percentage of the documents in whose byline there appear authors of various countries, NI: (Normalized Impact) Average normalized citation received by each document, %Exc10: Percentage of documents among the 10% most cited of the same year, type, and category,%Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc1: Percentage of documents among the 10% most cited of the same year, type, and category.

Region	Ins.	With respect to total			Averages per institution							
		%Ins	%RG	%Exc10 RG	%Ndoc	Ndoc	%RG	%IC	NI	%Exc10	%Exc10 RG	%Exc1
Western Europe	207	32.09	33.01	41.65	4.75	347	59.82	35.97	1.41	15.17	8.50	1.50
Northern America	96	14.88	21.88	25.76	3.27	505	55.38	30.78	1.53	16.42	8.20	2.19
Asiatic Region	160	24.81	22.76	16.58	5.32	292	60.74	22.58	0.94	8.71	4.86	0.95
Latin America	59	9.15	8.30	5.37	6.10	322	57.08	23.35	0.84	7.04	3.85	0.57
Middle East	52	8.06	5.67	4.50	3.22	212	68.46	22.34	0.99	9.29	6.16	0.92
Eastern Europe	28	4.34	3.89	1.96	11.68	255	72.30	24.47	0.85	7.15	4.35	0.58
Pacific Region	27	4.19	2.96	3.28	6.26	255	57.94	39.36	1.34	13.43	7.06	1.58
Africa	14	2.17	1.34	0.68	6.34	198	64.09	33.32	0.74	5.73	2.83	0.46
Total	645	100.00	100.00	100.00	5.09	332	60.32	29.24	1.18	11.92	6.56	1.28

Table A3
Number of institutions, percentages with respect to total, and averages per institution, by country. Abbreviations: Ins: Number of Institutions, %Ins: Percentage of Institutions, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Ndoc: Percentage of documents, Ndoc: Number of documents, %RG: Percentage of documents in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %IC: Percentage of the documents in whose byline there appear authors of various countries, NI: (Normalized Impact) Average normalized citation received by each document, %Exc10: Percentage of documents among the 10% most cited of the same year, type, and category,%Exc10 RG: Percentage of documents among the 10% most cited of the same year, type, and category in which an author of the corresponding institution acted as Research Guarantor (corresponding author), %Exc1: Percentage of documents among the 10% most cited of the same year, type, and category.

Country	Ins.	With respect to total			Averages per institution							
		%Ins	%RG	%Exc10 RG	%Ndoc	Ndoc	%RG	%IC	NI	%Exc10	%Exc10 RG	%Exc1
United States	78	12.09	18.90	21.45	3.12	517	56.17	28.60	1.51	16.00	8.15	2.24
South Korea	40	6.20	5.28	2.60	6.70	291	58.31	17.29	0.78	6.66	3.14	0.74
Spain	39	6.05	8.18	11.21	5.42	384	69.98	26.84	1.39	14.80	10.08	1.34
China	38	5.89	7.12	6.43	3.45	350	65.16	23.09	1.09	10.73	6.54	1.02
Japan	31	4.81	3.13	1.48	4.02	224	55.96	24.49	0.76	6.12	3.04	0.39
Italy	30	4.65	4.61	4.46	2.70	304	65.52	23.39	1.33	12.92	7.57	1.27

(*continued on next page*)

Table A3 (*continued*)

Country	Ins.	With respect to total			Averages per institution							
		%Ins	%RG	%Exc10 RG	%Ndoc	Ndoc	%RG	%IC	NI	%Exc10	%Exc10 RG	%Exc1
France	29	4.50	5.19	6.06	4.85	416	51.00	40.38	1.33	14.48	7.24	1.00
Brazil	29	4.50	5.02	2.87	6.56	386	56.76	11.77	0.69	5.36	3.10	0.42
Turkey	29	4.50	3.42	2.75	3.39	211	71.69	14.56	0.99	9.52	6.75	0.87
Germany	25	3.88	3.04	3.63	3.88	267	57.39	37.08	1.32	14.46	7.34	1.60
United Kingdom	23	3.57	1.98	2.64	2.91	211	51.47	51.33	1.43	15.99	7.89	1.93
Australia	19	2.95	2.01	2.17	1.59	243	56.78	37.44	1.32	13.21	6.79	1.60
Canada	18	2.79	3.69	4.85	3.90	452	51.93	40.20	1.59	18.25	8.43	2.00
Taiwan	15	2.33	1.47	1.35	4.39	223	51.34	12.83	1.13	11.93	5.18	1.03
India	14	2.17	3.26	2.18	4.63	377	76.59	11.13	0.89	8.08	6.48	0.97
Mexico	11	1.71	0.96	0.75	8.56	215	49.86	33.66	0.97	8.77	4.24	0.72
Argentina	10	1.55	1.69	1.30	4.84	363	58.56	25.52	1.10	9.39	5.26	0.64
Poland	10	1.55	1.81	0.71	10.32	308	77.60	18.99	0.77	6.48	4.14	0.59
Portugal	10	1.55	1.24	1.75	6.32	277	58.59	36.78	1.56	16.94	9.66	2.35
Iran	10	1.55	1.08	0.84	2.39	214	64.79	17.04	0.94	8.40	5.48	0.91
Netherlands	9	1.40	1.65	2.29	8.54	456	48.47	43.28	1.84	21.76	9.82	1.73
Thailand	9	1.40	1.02	1.01	5.49	250	53.50	48.12	1.15	11.71	5.72	0.87
New Zealand	8	1.24	1.05	1.18	17.36	281	60.69	43.92	1.37	13.96	7.69	1.52
Greece	7	1.09	1.10	1.47	4.95	283	71.57	22.51	1.36	15.14	11.23	1.54
Malaysia	6	0.93	1.43	1.13	10.03	420	65.04	21.56	0.84	7.37	5.01	1.04
Belgium	6	0.93	1.39	2.10	1.58	462	62.87	47.21	1.57	17.41	10.44	2.16
Nigeria	6	0.93	0.63	0.11	9.59	203	67.78	19.52	0.45	2.47	1.18	0.00
Ireland	5	0.78	1.60	2.44	11.53	685	62.50	31.49	1.59	19.18	11.16	2.74
Finland	5	0.78	0.82	1.01	6.42	345	61.47	35.32	1.47	17.35	9.27	1.38
Norway	5	0.78	0.49	0.51	15.03	253	49.75	39.01	1.30	12.77	6.24	0.79
Egypt	5	0.78	0.48	0.27	4.06	205	57.91	40.10	0.89	6.81	3.89	0.54
Switzerland	4	0.62	0.42	0.47	2.81	224	63.01	45.77	1.24	12.98	7.04	0.63
South Africa	4	0.62	0.48	0.40	3.27	239	64.11	38.60	1.02	9.20	4.47	1.03
Austria	4	0.62	0.39	0.46	3.11	229	54.12	57.63	1.68	17.23	7.99	2.94
Denmark	3	0.47	1.38	1.42	2.56	991	60.31	45.08	1.43	14.36	7.31	0.96
Sweden	3	0.47	0.60	0.59	2.33	425	57.42	47.48	1.27	13.51	7.27	0.97
Czech Republic	3	0.47	0.34	0.24	3.68	225	61.52	27.85	1.10	9.75	5.95	0.09
Israel	3	0.47	0.41	0.52	3.62	275	65.03	42.86	1.54	17.28	10.63	2.21
Chile	3	0.47	0.37	0.36	2.56	241	65.55	37.38	1.29	12.86	7.99	1.81
Hungary	3	0.47	0.22	0.07	23.10	145	63.32	24.18	0.61	4.52	2.53	0.48
Bangladesh	3	0.47	0.22	0.20	24.01	142	64.24	59.03	1.26	9.47	7.59	5.68

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