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INSTITUTO DE INGENIERÍA DE  
ALIMENTOS PARA EL DESARROLLO

**UNIVERSITAT POLITÈCNICA DE  
VALENCIA**

***BIBLIOMETRIC ANALYSIS OF  
AGROFOOD RESEARCH***

**TRABAJO FIN DE MÁSTER UNIVERSITARIO EN GESTIÓN DE LA  
SEGURIDAD Y CALIDAD ALIMENTARIA**

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*Curso Académico: 2020/2021*

**VALENCIA, 11 DE SEPTIEMBRE 2021**

# **BIBLIOMETRIC ANALYSIS OF AGROFOOD RESEARCH**

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## **RESUMEN**

En la actualidad se genera una gran cantidad de literatura científica y técnica que queda recogida en diversas bases de datos. El análisis sistemático de esta información permite analizar aspectos relevantes como la evolución de las temáticas de interés en un área de conocimiento, los temas más actuales en los que se está trabajando, la contribución de un país a dichas temáticas, así como las colaboraciones entre países. El objetivo del presente trabajo es realizar un análisis bibliométrico que permita establecer la evolución de las temáticas en las publicaciones sobre agroalimentación, las tendencias de investigación en dicha área, así como la importancia de España con respecto al resto del mundo en la generación de las publicaciones analizadas. Para ello se realizaron búsquedas bibliográficas en diferentes bases de datos, Scopus, Dimensions y Web of Science. Los resultados de las búsquedas fueron analizados mediante el software VOSviewer, que permite construir y visualizar redes bibliométricas. Los análisis a partir de búsquedas realizadas en varias bases de datos permitieron determinar diferencias. Los resultados del análisis bibliométrico permitieron detectar tendencias de investigación y vacíos de conocimiento en el área de agroalimentación lo cual puede ayudar a identificar temas para nuevos proyectos de investigación.

**PALABRAS CLAVE:** Análisis bibliométrico, agroalimentación, bases de datos; tendencias; investigación

## **ABSTRACT**

At currently, a large amount of scientific and technical literature is generated that is collected in various databases. The systematic analysis of this information makes it possible to analyze relevant aspects such as the evolution of the topics of interest in an area of knowledge, the most current topics that are being worked on, the contribution of a country to these topics, as well as collaborations between countries. The aim of this work is to carry out a bibliometric analysis that allows to establish the evolution of the themes in the publications on agri-food, the research trends in this area, as well as the importance of Spain with regard to the rest of the world in the generation of publications that have been analyzed. For this purpose, bibliographic

searches will be carried out in different databases, Scopus, Dimensions and Web of Science. The search results were analyzed using the VOSviewer software, which enables the construction and visualization of bibliometric networks. The analyzes based on searches carried out in various databases made it possible to determine differences. The results of the bibliometric analysis allowed the detection of research trends and knowledge gaps in the agri-food area, which can help identify topics for new research projects.

**KEYS WORDS:** Bibliometric analysis, agri-food, databases; trends; investigation

## **RESUM**

En l'actualitat es genera una gran quantitat de literatura científica i tècnica que queda recollida en diverses bases de dades. L'anàlisi sistemàtica d'aquesta informació permet analitzar aspectes rellevants com l'evolució de les temàtiques d'interès en un àrea de coneixement, els temes més actuals en què s'està treballant, la contribució d'un país a aquestes temàtiques, així com les col·laboracions entre països . L'objectiu d'aquest treball és realitzar una anàlisi bibliomètrica que permeti establir l'evolució de les temàtiques en les publicacions sobre agroalimentació, les tendències d'investigació en aquesta àrea, així com la importància d'Espanya pel que fa a la resta de l'món en la generació de les publicacions analitzades. Per a això es van realitzar cerques bibliogràfiques en diferents bases de dades, Scopus, Dimensions i Web of Science. Els resultats de les recerques van ser analitzats mitjançant el programari VOSviewer, que permet construir i visualitzar xarxes bibliomètriques. Les anàlisis a partir de recerques realitzades en diverses bases de dades van permetre determinar diferències. Els resultats de l'anàlisi bibliomètrica van permetre detectar tendències d'investigació i buits de coneixement en l'àrea d'agroalimentació la qual cosa pot ajudar a identificar temes per a nous projectes de investigació.

**PARAULES CLAU:** Anàlisi bibliomètrica, agroalimentació, bases de dades; tendències; investigació

## 1. INTRODUCTION

One of the most important sectors in Spain is the food and beverage industry, the efficiency levels achieved by the sector in recent years stand out very positively among all Spanish productive activities. In this sense, the level of apparent labor productivity in this sector is more than 10% higher than the Spanish average. The high degree of efficiency achieved by the sector in recent years provides Spanish households with a greater supply of quality and competitive products than the average for the European Union and those of the main neighboring countries (FIAB., 2020). The industry has almost half a million members of social security, with a female employment rate of 36% and that increases to 52% in R&D&I positions and youth occupation, which accounts for a third of jobs in the sector (García de Quevedo et al., 2021).

The issue that the food sector presents in Spanish is that it is mainly constituted by small and medium-sized companies, which are very sensitive to crises. Between the months of March and September 2020, the sector has suffered, on a global level, a significant drop in production which, despite the adjustment measures adopted, has caused a significant deterioration in profitability. In turn, there has been a significant decrease in the number of companies in the sector and in the level of employment (FIAB, 2020). Even so, the agri-food sector became a basic sector during the COVID-19 pandemic by presenting an essential activity in the supply of food for the population. The primary sector gained weight in the Spanish economy as a whole in the second quarter of 2020, contributing 3.8% of Gross National Income (GNI) compared to the contribution of 2.7% registered in 2019. Exports from January to July 2020 increased by 4.9% year-on-year in a context of the global economic crisis (CaixaBank., 2020), As can be seen in table 1.

**TABLE 1:** The weight is the value of agri-food exports of each product over total Spanish agri-food exports. Variation between January and July 2020 compared to the same period of the previous year. Caixabank., 2020.

**Top 10 de los productos agroalimentarios exportados**

TARIC	producto	Exportaciones en 2019 (millones de euros)	Peso en 2019	Variación enero-julio 2020
0203	Carne de animales de la especie porcina	4.582	9,1%	34,6%
0805	Agrios (cítricos) frescos o secos	3.198	6,4%	18,2%
1509	Aceite de oliva y sus fracciones	2.931	5,8%	-7,4%
2204	Vino de uvas frescas	2.739	5,4%	-5,4%
0709	Las demás hortalizas, frescas o refrigeradas	2.057	4,1%	6,7%
0810	Las demás frutas u otros frutos	1.720	3,4%	-1,2%
1905	Productos de panadería, pastelería y galletería	1.075	2,1%	4,0%
0809	Albaricoques, cerezas, melocotones, ciruelas y endrinas, frescos	1.070	2,1%	17,2%
2005	Las demás hortalizas preparadas	975	1,9%	-1,4%
0702	Tomates frescos o refrigerados	922	1,8%	1,7%
	<b>Total exportaciones agroalimentarias</b>	<b>50.361</b>	<b>100,0%</b>	<b>5,4%</b>

Currently, apart from the COVID-19 crisis, the industry faces several pre-pandemic challenges from before the pandemic occurred. One of them could be referred as "over supply" of food, that is, the consumer becomes

saturated by the high amount of available food products, the different forms of presentation, the varieties within the same line, the large number of brands of the same product, etc. Therefore, right now people are looking for something beyond food, something else to eat (Burgueño de la Cal., 2020). Another challenge that the industry faces is food safety, because the food available has must be produced ensuring that its consumption does not represent a risk for a health hazard. Nevertheless, food safety is another important concern since due to the increase in population, and the risks of not being able to produce enough food as a result of extreme events induced by climate change, change in land use and the imminent reduction of available water in volume and quality acceptable for agriculture, make food production unviable for the entire world population (Pérez et al., 2018).

The quality of food is another of the challenges that the Spanish industry must face. The competitiveness is increasing due to the development of globalization which causes that the industry has to renew itself and find a way to produce high-quality products that differentiate it from its competition in other countries.

The sustainability of the industry is another of the hurdle. This challenge is of vital importance because of the effects of climate change in this industry, due to the relationship of global warming with the obtention of raw materials and resources that food industry uses. Finally, the digitization of the food industry is another challenge, which has proven its importance during the pandemic, noting that electronic commerce has experienced a boom during the COVID-19 crisis. "CaixaBank virtual POS payments show, as of the second half of April, a strong upturn in e-commerce, which still maintains very high growth rates, close to 60%" (CaixaBank., 2020). For that reason, the future of the industry will bring us to the food chain 4.0, a fully connected ecosystem between the field and the table. Therefore, to have a wide perspective of the above-mentioned challenges, it is proposed to make an analysis of the scientific works related to them through the use of bibliometric tools.

## **2. OBJECTIVE**

This work aims to obtain the existing trends in the scientific field on the agri-food sector related with sustainability, safety, quality and technology 4.0 through a bibliometric analysis and to be able to highlight the role of Spain in the international community in the development of scientific documents on the aforementioned topics.

### 3. METHODOLOGY

To obtain the data set to carry out the bibliometric study, the Web of Science (WoS), Dimensions and Scopus databases were used being Scopus and WoS the most relevant for this work. The WoS is a web platform that collects the references of the main scientific publications of any discipline of knowledge (Universidad de Cordoba, 2020). Scopus is a bibliographic database started in 2004, from abstracts and citations of articles from scientific journals (Llurba., 2020). Dimensions is a Digital Science scientific information platform, including a citation database, a suite of research analysis, and modern article discovery and access functionality (Universidad de Cadiz., 2021). Dimensions is a source of scientific information that since 2018 has begun to have increasing importance in the field of scholarly communication. This source represents the collaboration among six companies from the Digital Science portfolio (Altmetric, Digital Science Consultancy, Figshare, Readcube, Symplectic and ÜberResearch) (<https://www.dimensions.ai/why-dimensions/>).

The considered time interval was between 2010 and 2020. The keywords for each of the topics were: "agri food" for the agri-food sector; "Safety food" or "health food" or "food distribution security" for food safety; "Agri food quality" for food quality; "Sustainability agri food" for sustainability and "food industry 4.0" for technology 4.0. The tool used for the creation of bibliometric maps was VosViewer (van Eck, N.J., Waltman, L., 2017). A bibliometric network consists of nodes and edges. The nodes can be, for instance keywords or countries. The edges indicate relations between pairs of nodes. Among the most commonly studied types of relations are keyword co-occurrence relations and coauthorship relations. Hence, edges indicate not only whether there is a relation between two nodes or not but also the strength of the relation (van Eck, N.J., Waltman, L., 2014).

Two kinds of maps were obtained: co-occurrence of keywords and co-authorship by country. The number of co-occurrences of two keywords is the number of publications in which both keywords occur together in the title, abstract, or keyword list (van Eck, N.J., Waltman, L., 2014). In the same way, the co-authorship network, nodes represent authors and a connection between two authors exists if they have co-authored a study. Co-authorship networks showing collaborations among countries were produced (Barbosa., 2021). In addition, the VosViewer tool allows to observe maps divided into interrelated groups, called clusters, and maps that allow us to see the appearance of keywords and producing countries at intervals of years of documents. Due to this characteristic of the tool, the part of the work based on keyword maps focused on finding those words that were most used in the different documents, which keywords have appeared over time and which could point out new trends in the five topics covered in the work. On the maps

based on the co-authorship of countries, it was studied which countries were most relevant in the production of scientific works, which began sooner or later and how agree on the international framework Spain and try to highlight its contribute on to the world scientific.

#### 4. RESULTS AND DISCUSSION

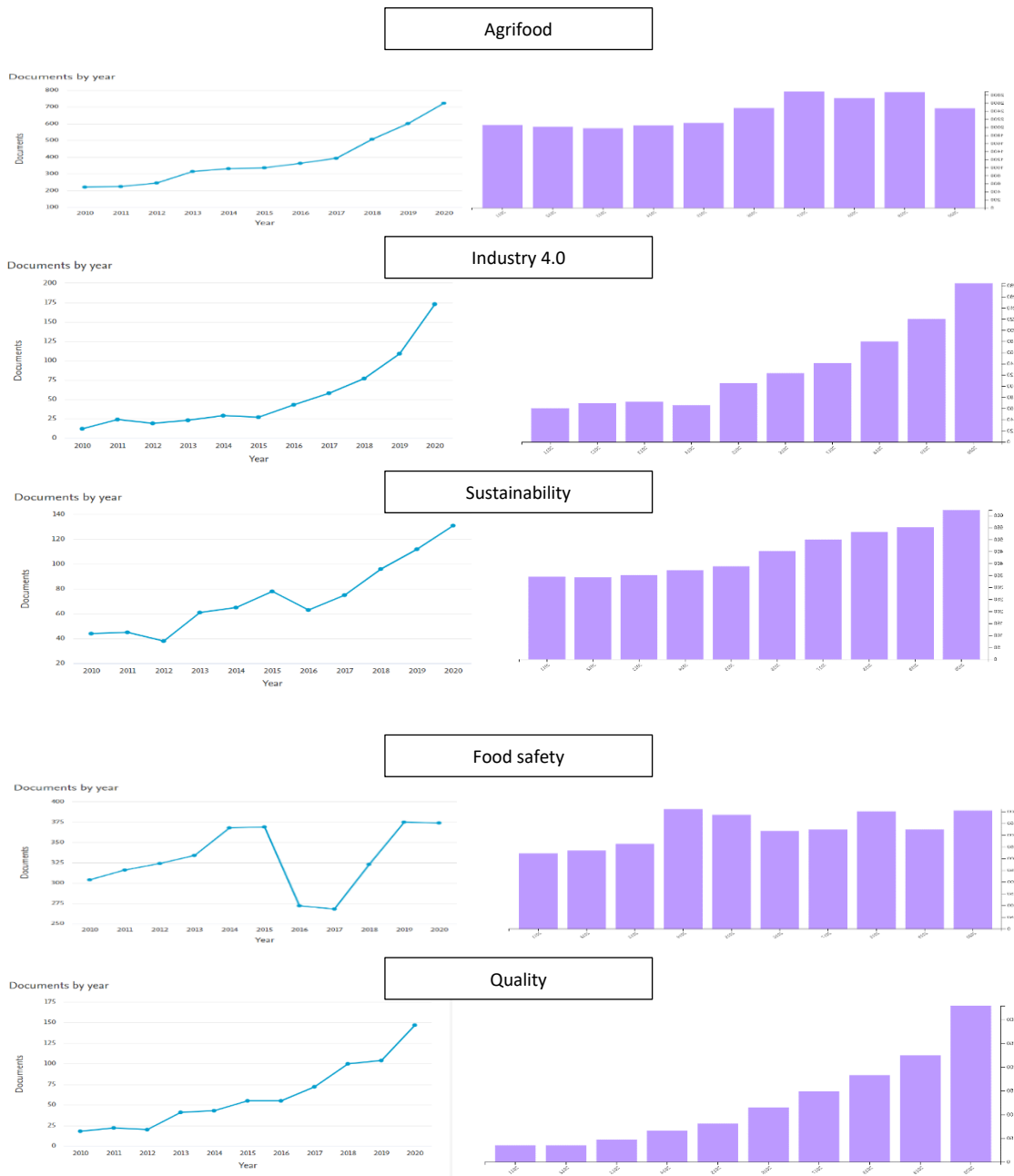
Table 2 shows the number of documents found in each of the searches with the keywords mentioned in the previous section. WoS contains mostly prestigious journals, while Scopus covers a greater number of lower impact journals with which its results are higher. Dimensions, in addition to include scientific works, also contains another documents such as mentions, web pages, patents, conferences, etc. For that reason, the number of documents obtained with this database are the highest and its results are higher than those of the other two databases together. Nevertheless, its main disadvantage is that it cannot be obtained bibliometric maps by keywords from it. Barbosa (2021) developed a bibliometric analysis about food supply change. Nevertheless, in this work only WoS database was used. As it is pointed out in table 2, the number of documents is different depending on the database, thus in order to get a broad view of trends, it is interesting to analyse the results from all of them.

**TABLE 2:** Number of documents obtained from the different databases for each of the topics covered in the work.

TOPIC	DATABASE	DOCUMENTS
AGRI FOOD	WoS	3595
	Scopus	4242
	Dimensions	174904
FOOD SAFETY	Scopus	3627
	WoS	1651
	Dimensions	328972
QUALITY	Scopus	802
	WoS	742
	Dimensions	134286
SUSTAINABILITY	Scopus	672
	WoS	594
	Dimensions	67885
INDUSTRY 4.0	Scopus	591
	WoS	543
	Dimensions	466833

## 4.1 Evolution of documents through publication

Figure 1 consists of several graphs that show the number of documents that have been produced per year. The line graphs show the documents extracted from Scopus while the bar graphs show those from WoS.



**FIGURE 1.** Evolution of the number of documents through years in Scopus (left) and WoS (right) databases.

In the vast majority of the topics covered, an exponential growth in the number of documents produced in recent years was observed, the only one that decreased its number of documents was the subject of agrifood with respect



to previous years in WoS. A graph that stands out above the rest is the one related to food safety in which there was an anomalous decrease in the number of documents from 2014. This effect stands out in the Scopus figure although a not so significant decrease in the number of documents is detected in WoS. More studies would have to be carried out to determine what caused this decrease in document production. As it can be seen in the two types of graphs, the results of the two databases have the same tendency except for the above-mentioned case.

#### **4.2. Co-occurrence keywords**

A network of co-occurrence was formed by looking at the agri food keywords with the VosViewer tool. Co-occurrence networks are generally used to provide a graphical visualization of the possible relationships between words, people, organizations, and concepts (Freilich et al., 2010). Table 3 is made up of the 3 most relevant words of the top 10 with the highest occurrence of the different searches carried out in the databases.

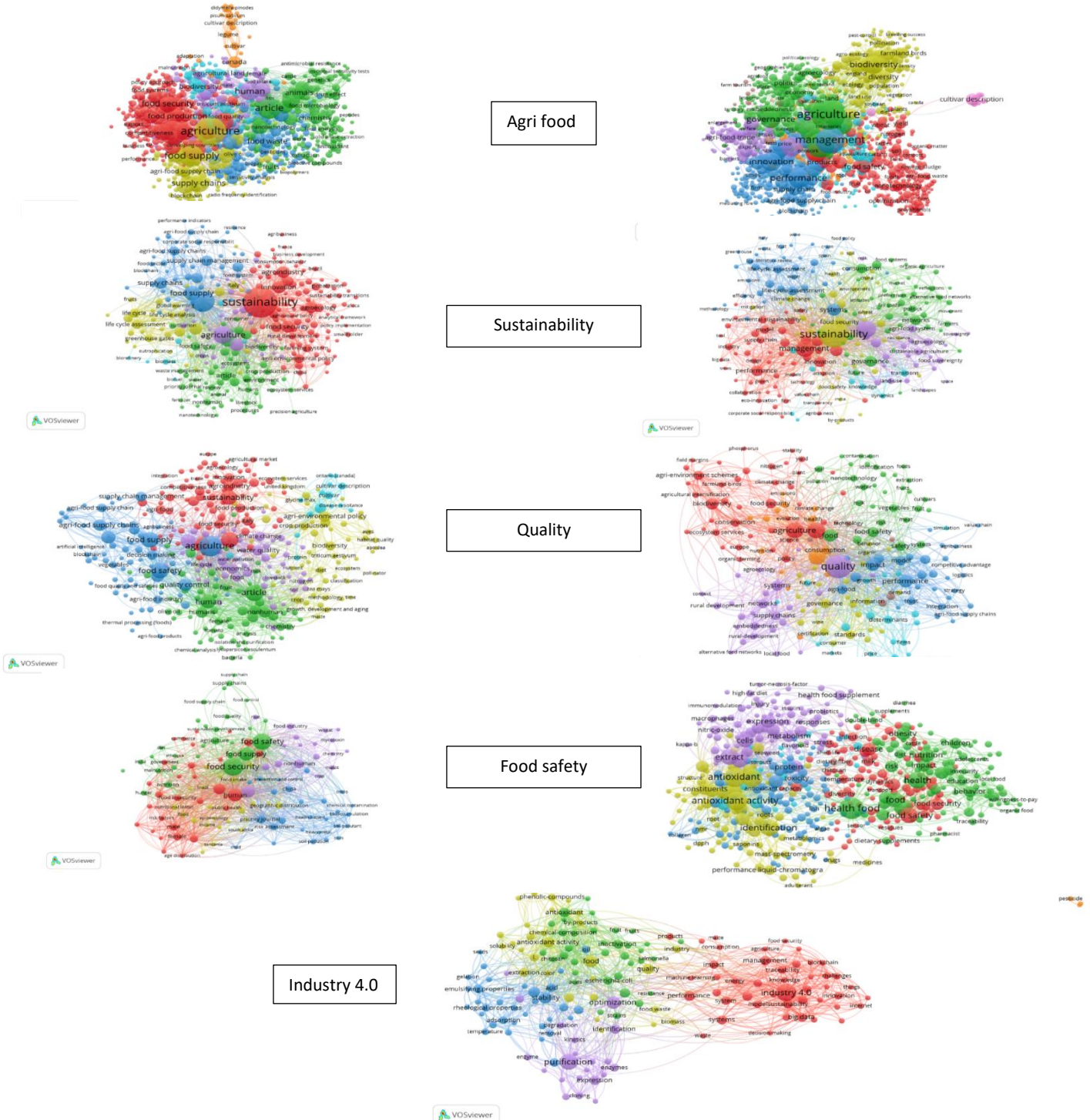
The word food supply was a very recurrent one in the documents extracted from Scopus, appearing in practically all the topics covered. This shows the importance of food chains in the industry and a possible topic to be discussed in future works. In WoS the most recurrent words were management and performance, in almost all the subjects, being the named ones. In agri food the word sustainability appeared in both databases, which indicates the importance that sustainability is having in the production of scientific documents. In food safety the words in Scopus focused more on food security and WoS on health and antioxidant activity, this may be due to the recent regarding antioxidants that have been present in scientific papers. In sustainability, the Scopus database focused more on the food industry and climate change, while in WoS it focused more on business administration.

**TABLE 2:** The most frequent words in the documents in WoS and Scopus.

DATABASE	TOPICS	KEYS WORDS	OCCURENCE
Scopus	Agri food	Sustainability	194
		Food supply	150
		Sustainable development	140
	Food safety	Food security	92
		Food supply	59
		Human	57
	Sustainability	Food supply	78
		Climate change	54
		Food industry	53
	Quality	Food safety	70
		Food supply	69
		Food quality	66
	Industry 4.0	Optimization	31
		Antioxidant	21
		Quality	21
WoS	Agri food	Management	288
		Sustainability	254
		Performance	154
	Food safety	Health food	100
		Antioxidant	79
		Antioxidant activity	75
	Sustainability	Management	96
		Performance	43
		Governance	43
	Quality	Management	66
		Sustainability	61
		Performance	41
	Industry 4.0	Innovation	149
		Quality	144
		Food security	144

Regarding quality in the Scopus database, keywords such as food safety appeared, being able to relate the quality of food with its safety. In WoS, quality was related to the words named at the beginning of the paragraph and to sustainability. Finally, in the two databases the word quality appeared in industry 4.0 and the keywords of optimization and antioxidant were differentiated in Scopus, while in WoS, innovation and food security appeared.

Once the most relevant keywords had been analyzed, several bibliometric maps were made. Figure 2 shows the bibliometric maps divided by clusters, in the left part of the figure are the maps made by Scopus and in the right part those made from the WoS searches. Furthermore, in industry 4.0 it was not possible to make a bibliometric map with Scopus. The most important clusters



**FIGURE 2:** Bibliometric maps of keywords by co-occurrence divided by clusters of the Scopus (left) and WoS (right) databases.

used for the analysis were the first five, the first cluster being red, the second green, the third blue, the fourth yellow and the fifth purple. Clusters that are located close to each other on the map indicate closely related fields (van Eck and Waltman, 2010).

The first two maps in Figure 2 were made with the agri-food data. The first Scopus cluster was related to the economy or the production system such as: capitalism, agri-food sector, commercialization, and sustainability. The next cluster contained the words antibiotics, antioxidants, and nanoparticles. The third cluster was located in the center of the image, with what was more related to the other clusters, having words related to waste and energy. The fourth cluster is related to supplies and distribution. In the fifth cluster, the most important words were related to human health and food. While in WoS the first cluster was related to food safety and quality, the largest node being quality. The second cluster contained words related to agriculture, economy and sustainability, the most repeated words being: agriculture, sustainability, food, governance, and systems. A large part of the words with the most citations are found in this cluster. The most important words in the third group were management, performance, and innovation. The fourth cluster was related to the environment. The fifth cluster had the fifth most relevant word, this being impact.

In the maps made by the data obtained from the search with sustainability topic, it was obtained that in both the Scopus and WoS maps the sustainability node was the most important. As it has been pointed out before in Scopus, the first cluster was more related to sustainability, while in WoS what predominated were words related to administration. In the second cluster Scopus was more related to the environment and in WoS issues related to globalism predominated. The third group in Scopus was related to supply chains and in WoS it was grouped by words related to ecology. The fourth group is related to the environmental impact in Scopus while in WoS it is the cluster with the largest node, this being sustainability. The fifth cluster in Scopus had almost no relevance and in WoS the largest node of the fifth cluster was performance.

In the maps derived from quality, in Scopus the first cluster was the second with the largest nodes only surpassed by the third cluster, these nodes were sustainability, food quality and food industry. The second cluster was related to health. The third cluster with the largest nodes was located on the left and was related to the power chains. The fourth is related to the ecosystem and the fifth that is located in the center is related with climate change. In WoS, the first cluster is the cluster with the largest number of large nodes, the second cluster is related to food security, the third with impact and optimization, the fourth was a cluster of importance and the fifth contained the node bigger, which is quality.

In the food safety maps, in Scopus the documents highlighted food security more while in WoS health food was more relevant, the Scopus map can clearly differentiate the largest nodes from the smallest, while in WoS they obtained large nodes to a greater extent and more distributed by the different clusters. Finally, in the map of industry 4.0, the separation that exists between the first cluster with the rest of the cluster can be clearly observed, which indicates a great difference in the subject with respect to the other clusters, in



future works we could try to carry out the Bibliometric map of the data extracted from Scopus.

Figure 3 shows bibliometric maps of the co-occurrence of keywords related to the years in which they have appeared. The Scopus maps are on the left and the WoS maps on the right, except for the agri food and industry 4.0 maps which are from WoS because the time interval in agri food was very small and not very representative, and the map of Industry 4.0 could not be performed from Scopus.

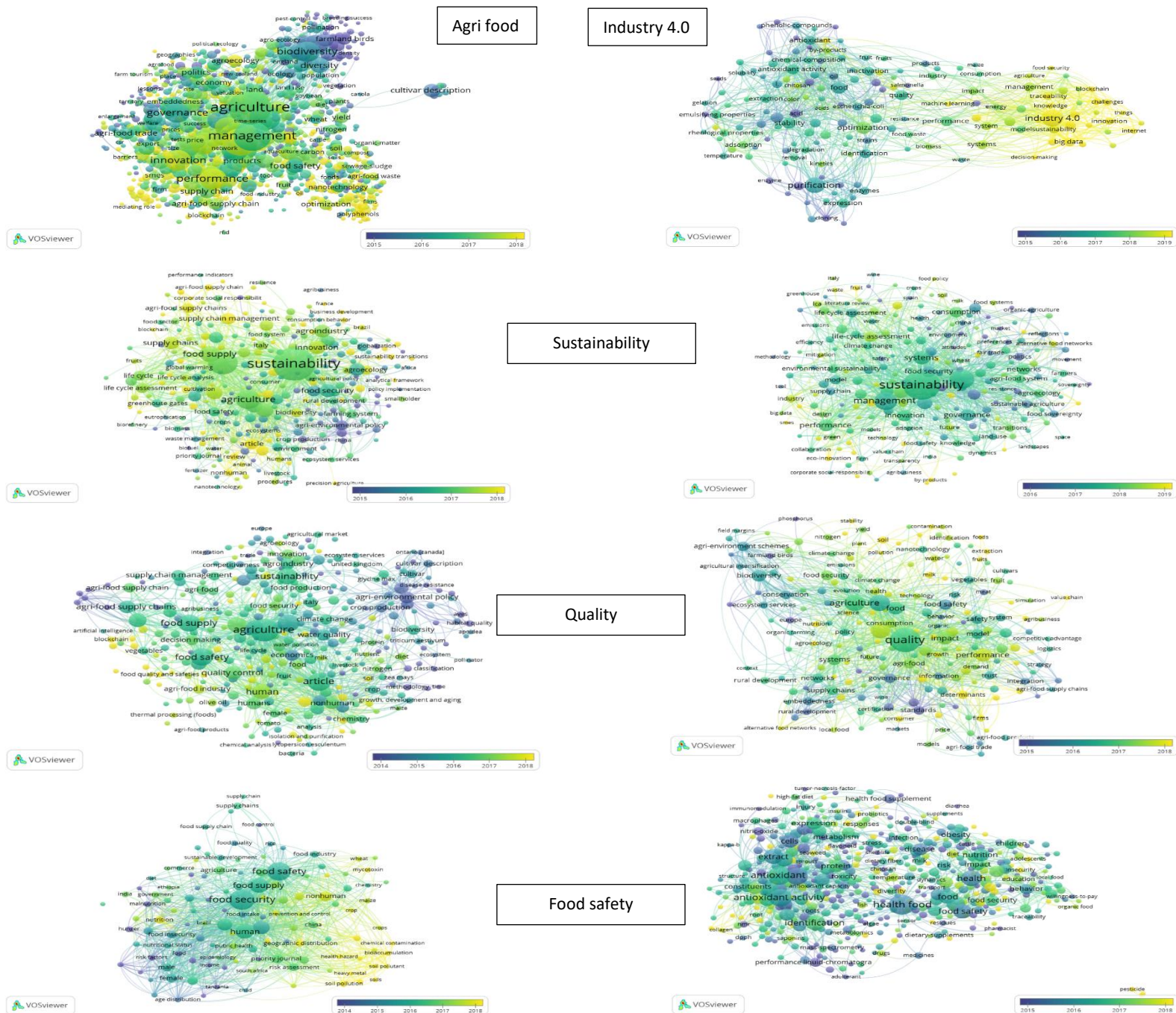


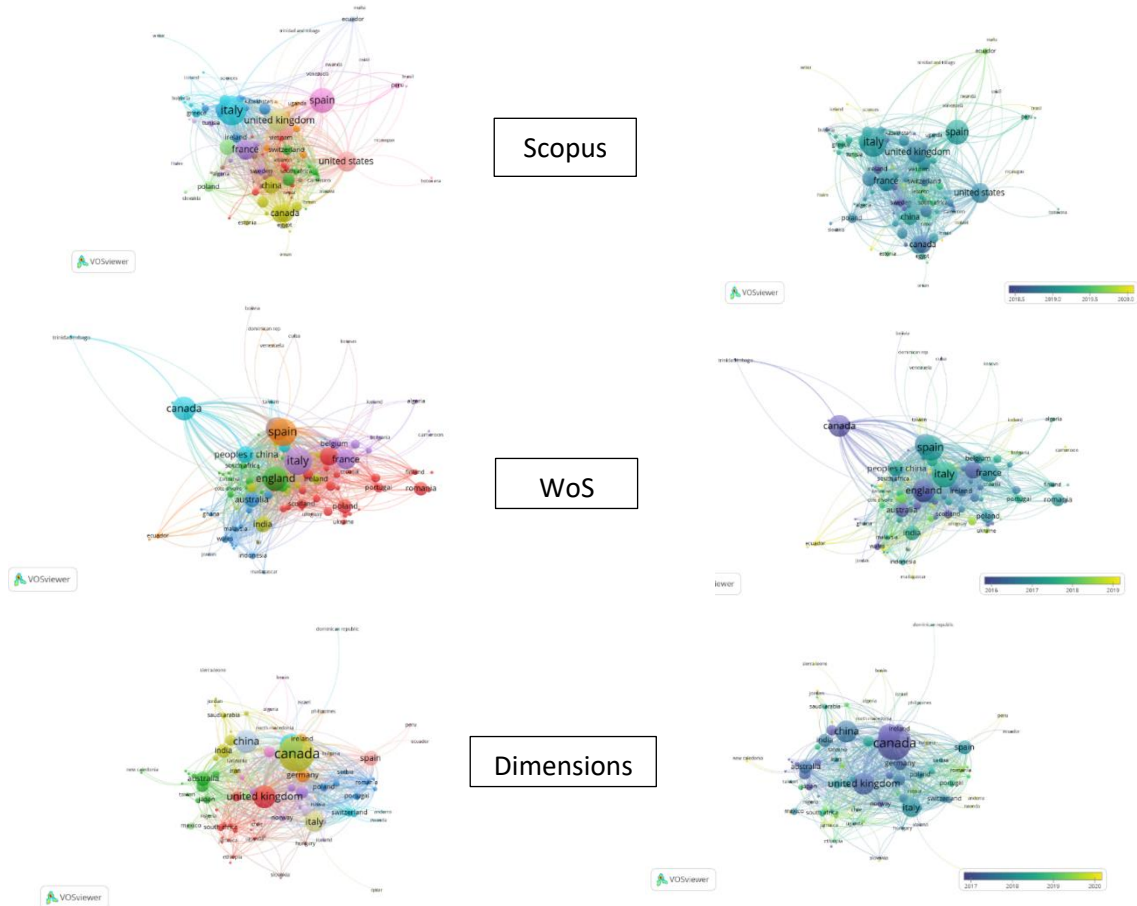
FIGURE 3: Bibliometric maps of keyword co-occurrence by time intervals in Scopus (left) and WoS (right) databases.

In the agri food map, the key words that have appeared in recent years with great relevance were sustainability, which again highlights its importance in the agri-food sector. Other words that also appeared frequently and of great importance were “performance” and “innovation”. Words in yellow but with smaller nodes could be words that highlight new trends and that have not had time to produce enough studies for their nodes to increase in size. Words that could have a great relevance in recent years are: food waste, robot agriculture, antioxidant and circular economy. In the Industry 4.0 map, it is observed that most of the words that appeared around 2019 are in cluster 1, which indicates that the new studies related to technology 4.0 are related to each other and are quite different from the previous studies. The new words that have appeared in recent years with a large node found in cluster 1 are industry 4.0 that is related to design and big data, which are words that have appeared recently, and with words such as quality and performance that appeared in previous years. Other words that have emerged recently are: innovation, internet, blockchain and sustainability. Recent words that are not in cluster 1 and may be of interest are: food safety, bioactive compounds and biofilm.

It is observed how in the two bibliometric maps of sustainability most of the words appeared in 2017-2018. In the Scopus map, the keywords that have currently appeared are: innovation, supply chain management and supply chains. While in WoS words that are appearing are: environmental impacts, circular economy and alternative food networks. The new words that have appeared recently in both Scopus and Wos demonstrate how scientific studies related to sustainability focus on supply chains and new technologies or systems that are more compatible with the environment. In terms of quality, most of the large nodes in the map extracted from Scopus were entered between 2016 and 2017, while in the WoS database the most important keywords appeared more recently, between 2017 and 2018. In Scopus the nodes that are growth or that may have a great future importance in the sector are: procedures, agricultural robots, food waste and traceability. However, in WoS the word sustainability appeared relatively recently in scientific works unlike in Scopus which appeared earlier and represents one of the largest nodes on the map, located next to quality. Other words of possible interest that appeared more recently were: performance, health, agroecology, nutrition and framework. In food safety, the Scopus map is observed as the majority of new words that have appeared more currently belong to cluster 3 and the most important nodes appeared between 2016 and 2017. Words that could have future relevance would be: bioaccumulation, soil pollution and environmental monitoring. All of them are closely related to the environment. On the WoS map, the largest nodes appeared around the same time as on the Scopus ones. The most current nodes are dispersed throughout the image unlike what happened in the previous one where the majority were congregated in a cluster. Keywords that may be relevant in the future are: sustainability, climate change and phenolic-compounds.

### 4.3. Co-authorship by country

Figure 4 shows different types of bibliometric maps from the different databases, the first two being made with Scopus, the second with WoS and the last two by Dimensions. The maps are divided on the left by clusters and the figures on the right by years.



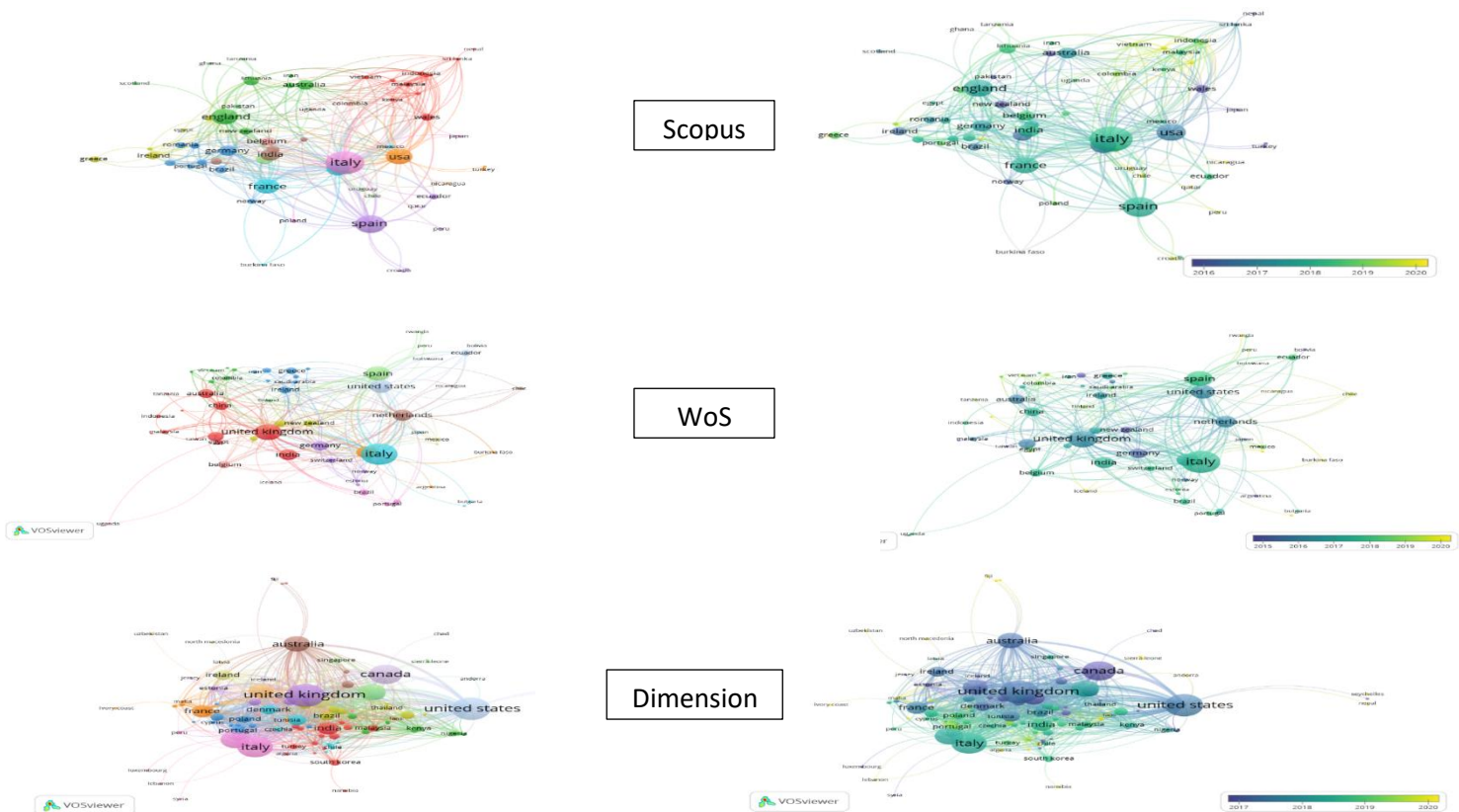
**FIGURE 4:** Co-authored bibliometric maps by countries made with documents extracted from Scopus, WoS and Dimensions for agri food by clusters (left) and by years (right).

Regarding the countries in the Scopus database, the three countries that produced the most documents were Italy, Spain and the United Kingdom. However, in the number of citations, Spain would drop one place and would be the third most cited country. In the image that shows the publication time scale, it is seen that most countries have already been publishing works on agri-food for a long time, so it is not observed that there is any important difference between the powers that are currently producing documents (it is necessary to say that the time scale that there is very small of 1 year and a

half). The most important countries in WoS were Italy, Spain and the United Kingdom, the order coinciding with that obtained with Scopus. Nevertheless, in the number of citations, Spain would drop to sixth place. The most relevant countries have been working on this issue for some time, although if one looks at how some countries started before others, such as the United Kingdom that started before 2016 and Spain and Italy between 2017 and 2018.

Regarding to Dimensions database, the country that has dealt with the subject the most is Canada, followed by the United States and China, which is a nation that has begun to produce documents a short time ago. Spain is in fifth position with 105 documents, starting a little later than China.

In figure 5 the results related to sustainability are shown. In the maps extracted from Scopus, the three countries that produced the vast majority of documents were Italy, Spain and USA. However, in the number of citations, Spain would drop to position 5. The image that shows the publication time scale shows how most of the relevant countries began to carry out studies in 2018 except USA, which started earlier. This image shows the importance of Spain in the international scientific community. The image is divided into 7 clusters with a resolution of 0.5 in which Spain is in cluster 5, most of the countries that are linked to Spain were European and Latin American countries. The figure Highlight that Spain has a great relationship with Italy and Ecuador.



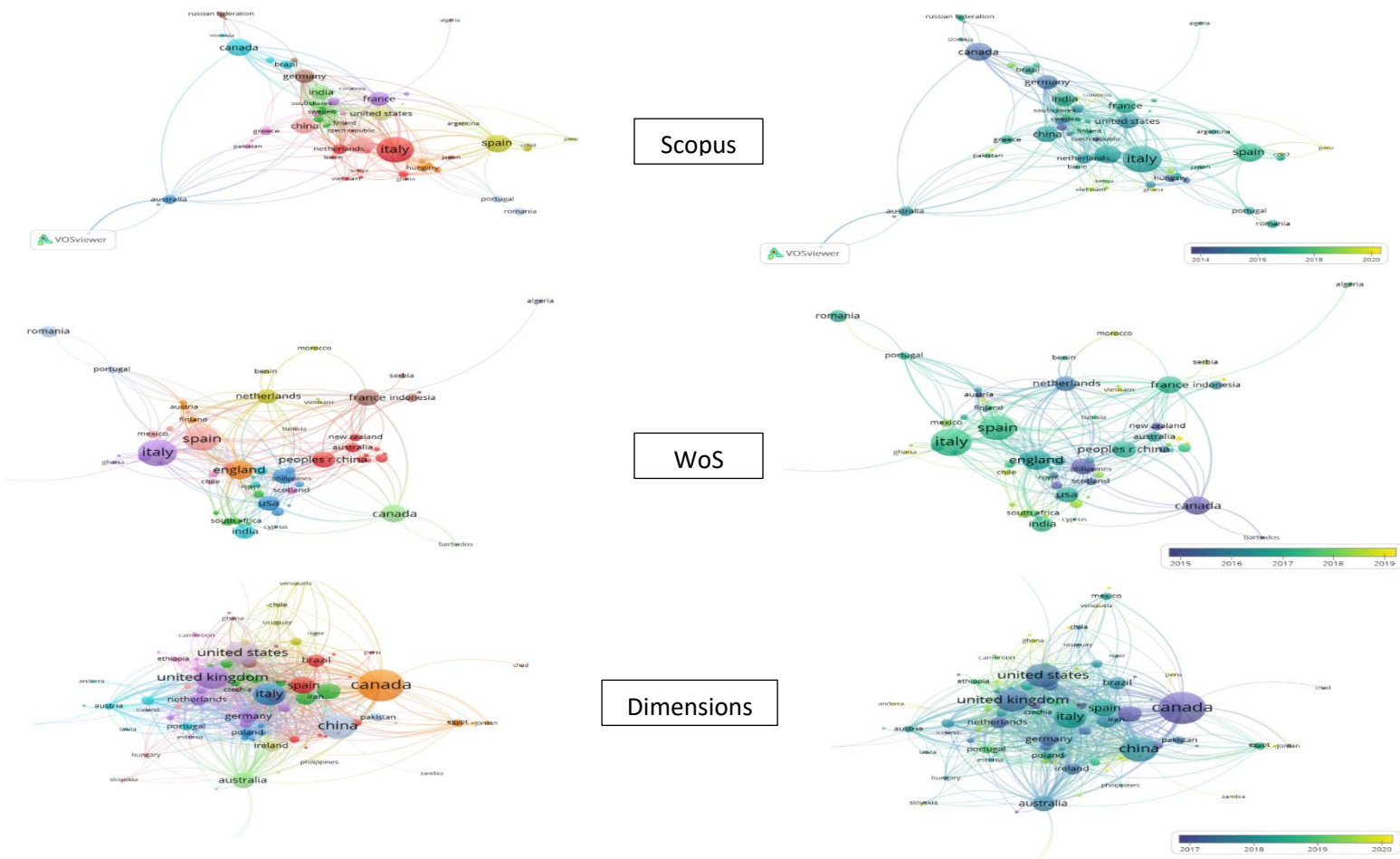
**FIGURE 5:** Co-authored bibliometric maps by countries made with documents extracted from Scopus, WoS and Dimensions for sustainability by clusters (left) and by years (right).



In the maps developed from WoS database, the countries that published the more documents were Italy, the United Kingdom and Spain. Regarding citations between countries, Spain would drop to the seventh position of the most cited countries, with the United Kingdom being the most cited with 2,211 citations and 94 studies. Spain was found in cluster 5 with 43 other countries such as: the Netherlands, Norway, and Ecuador. Spain had relations with most of the powers of Europe and in America it had relations with the USA, Ecuador and Mexico, having a greater link with Ecuador and the Netherlands. As for those that recently started producing documents, we see how the United Kingdom, Germany, and the Netherlands have been producing documents since 2016, while Italy started in mid-2017 and Spain, having started later in the production of documents (2018) was from the countries that more documents produced, and more citations obtained.

From the search from Dimensions, the countries with the most documents were the United Kingdom, USA, and Italy. Spain was in the fifth position in document production. Most of the countries that have large nodes began to produce documents in 2017, although there are some countries such as Italy, Spain, India, and China that began at the end of 2018. The map was divided into 16 clusters, Spain was in the ninth along with Italy and 4 other countries. Collaboration between countries and Spain was close between almost all European countries and the United States. Observing the maps obtained from the data collected from the different databases, Spain's position in the production and quality of documents is very high, always being among the 10 countries that produced the most documents and were most cited. This shows the country's involvement in scientific work related to sustainability and how it is a country that is at the forefront worldwide. It was also observed how Spanish documents were more related to Spanish-speaking countries and the European Union.

Figure 6 is related with quality search. For Scopus analysis, Spain drops to sixth position. The image is divided into 13 different clusters, Spain is in the fourth, which is made up of 8 countries, the majority being Hispanic. As for the years when they started developing documents more or less all the countries started at the same time except Germany and Canada which started earlier. In terms of aid between countries, it seems that Spain was closely related to the United Kingdom and France. In the case of WoS, the countries with the most documents were Italy, Spain, and the United Kingdom. In number of citations, Spain would drop to sixth place.



**FIGURE 6:** Co-authored bibliometric maps by countries made with documents extracted from Scopus, WoS and Dimensions for quality by clusters (left) and by years (right).

The countries with the largest number of documents were Italy, Spain, and the United Kingdom, in terms of citations, Italy would remain in the first position followed The image is divided into 14 different clusters in which Spain is in 10 with 4 other countries, of the 5 countries that make up the cluster where Spain is located, 3 of them are Spanish speakers. The links coming out of Spain show the relationship between all the countries that have had more documents, having a special link with France and the Netherlands. Spain began creating studies between 2017 and 2018 like most countries with a large number of documents except Canada, Germany and the Netherlands.

From Dimensions results, the countries with the highest number of documents were Canada, China, and the USA. Spain is in sixth place with 147 published documents. A large part of the countries began to publish documents in 2017, while other nations, which are among the countries that have been producing the most documents, started later, such as China, Spain, Brazil, and Italy. Spain is in the first cluster with 11 other countries, Spain collaborated with a

great number of countries having a closer relationship between European countries, Canada, and the USA.

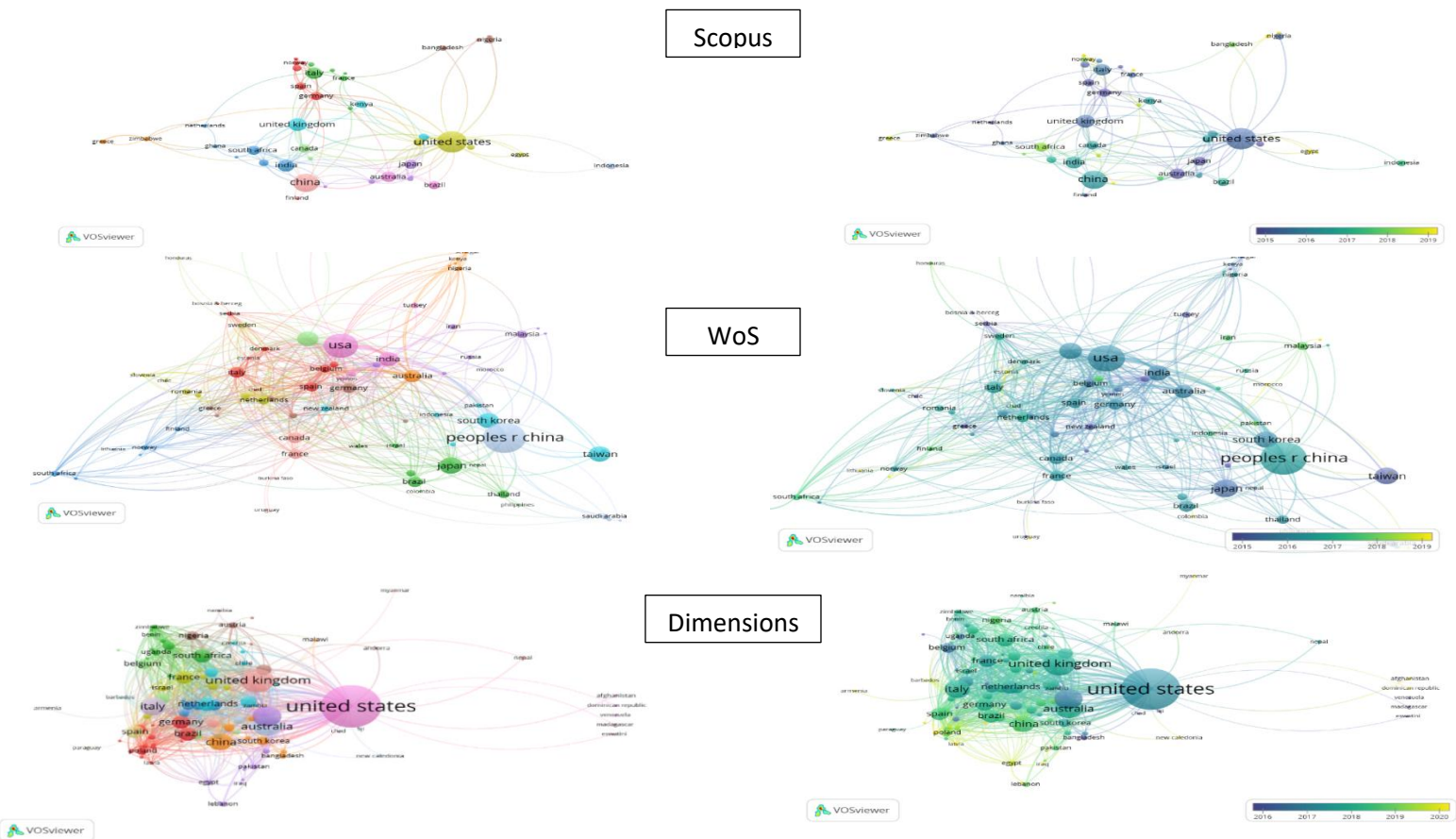
Figure 7 shows the bibliometric maps for food safety. The countries that produced most documents in Scopus were USA, China, and the United Kingdom. Spain being in eleventh place with only 7 documents. Regarding the citations, the first countries were USA, Australia, and China. Spain climbs up to the tenth place in the number of citations. The first image is divided into 12 clusters with Spain in the first, made up of 7 countries, most of them from the EU. In the second image, most of the countries appeared between 2015 and 2017.

In the case of WoS, the countries with the most documents were China, USA and Japan. While Spain was very prolific in the production of scientific works on previous topics, when it comes to food safety, Spain would be in the fourteenth position with only 41 published documents. However, with that amount of documents, the citations to these were 1109. Spain is in tenth place of the most cited countries, which could imply that their quality was very high. As for the image that shows the news of scientific documents, no country that has started today stands out and all more or less began to produce studies in 2017 with a few exceptions such as Japan and Taiwan that started earlier.

Scopus

WoS

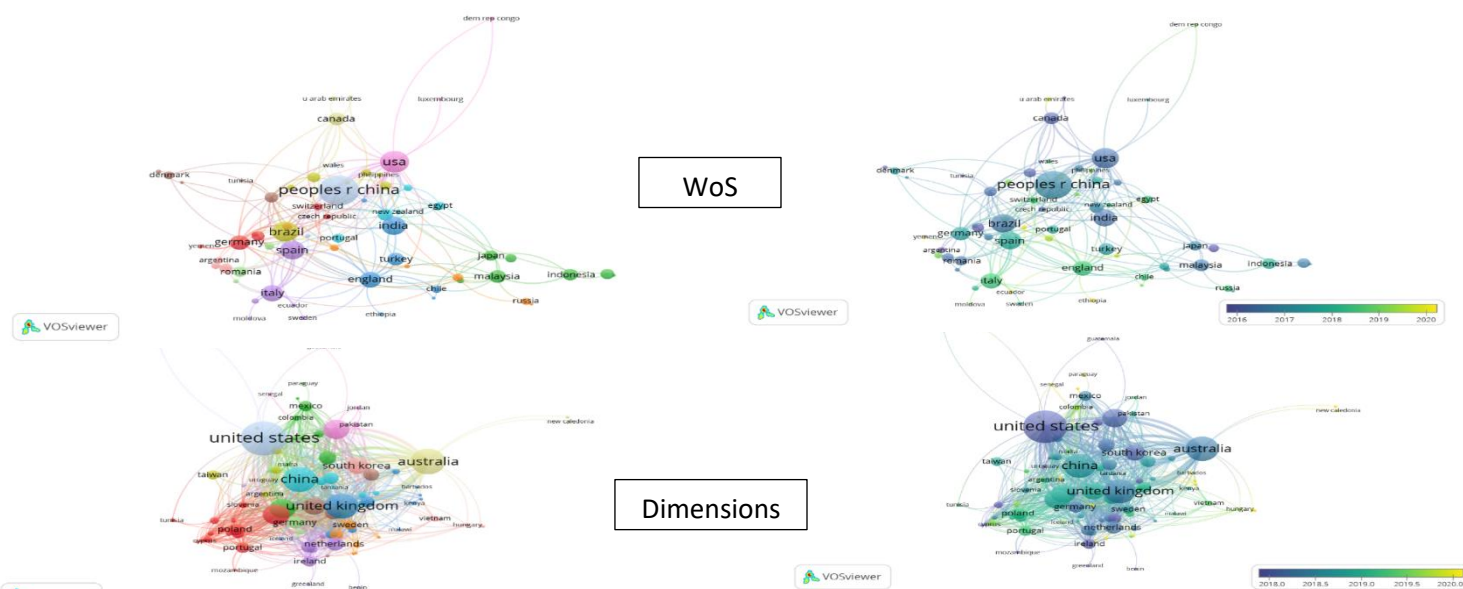
Dimensions



**FIGURE 7:** Co-authored bibliometric maps by countries made with documents extracted from Scopus, WoS and Dimensions for food safety by clusters (left) and by years (right).

Dimensions database analysis shows that United States greatly outperformed the rest of the countries in documents produced, followed by the United Kingdom and Canada. In this case, Spain was the twelfth country with the greatest number of documents, falling a lot compared to the other topics that have been treated in this work, as well as what happened in WoS, the number of clusters that appeared were 16, with Spain being in thirteenth next to Paraguay and Colombia. The links shown in the image with Spain are larger with France, the United Kingdom and the US. The collaborations that Spain had with other countries were mostly from the EU. Regarding the years, no country stands out especially. On the subject of food safety, it is observed that Spain produced fewer documents, but the number of citations of the Spanish works was very high in Scopus and WoS, which indicates a high quality of the works developed in Spain.

Figure 8 shows the bibliometric maps from industry 4.0 search. It is divided in two parts, in the upper part are the maps made from WoS and in the lower part those made from Dimensions. In the WoS database, the countries with the most documents were China, with a big difference compared to the other countries, followed by USA and Brazil. Spain being in fourth position with 39 documents. Regarding appointments, China, the USA, and Italy were the most cited countries, Spain down to the tenth position. The Spanish cluster is made up of 6 countries, the majority from Europe. In the bibliometric map by years, there is no country that stands out because it currently appears, except the Netherlands, the other countries began on the same time interval, although Spain, Italy, Germany, and England began a little later.



**FIGURE 8:** Co-authored bibliometric maps by countries made with documents extracted from WoS and Dimensions for industry 4.0 by clusters (left) and by years (right).

Regarding the Dimensions analysis, the countries with the highest number of documents were USA, Australia, and the United Kingdom. Spain is in sixth place with 156 documents. The first image is divided into 19 clusters with Spain in the second, green, being made up of 12 different countries, half of which are Hispanic. The node for Spain is located on the left side of the United Kingdom. Industry 4.0 is a topic that has appeared recently, this is known because the time scale that the program automatically performs is two years with which most of the studies have emerged between 2018 and 2019, without highlighting any country in seniority compared to the others. Although Spain, Italy, Brazil, and China started later than the others, still positioning themselves in the highest positions of document production.

## **5. CONCLUSIONS**

The increasing production of scientific papers on agri-food sector highlights the growing interest of scientific community on it.

Regarding the keyword maps, different results were obtained depending on the database used, in which Scopus is the one where appears words more related to sustainability and in WoS words related to administration. One of the most important words was “sustainability” both in one database and in the other, which could be a topic of great interest for future related works. Food chains were also of great interest in the databases. Possible future trends are related to sustainability and better food collection systems. It must be taken into account that to carry out this study only keywords were taken into considered, with which new studies could be carried out that use more precise tools for future work.

In the study of document production by countries co-authorship, it was pointed out that Spain is one of the countries that produces more documents, being almost always among the ten countries that had contributed the most in number of documents. Furthermore, the works produced in Spain are highly cited by other countries. Most of the clusters where Spain was located met with countries of European origin or Spanish-speaking countries, being closely related to them.

## 6. AGRADECIMIENTOS

I dedicate these thanks to my tutor Gabriela, who was always attentive to me and whenever I speak to her, she answers me immediately to resolve my doubts. To Neus, who although I have not had much contact with her, has been helping and reviewing my work. To the Ainia Chair for offering me this opportunity and financing me to carry out the study.

To my family and friends for continuing to support me and put up with me during all this time.

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