Research Open Access

hvegasanche@uniminuto.edu.co

Correspondence:

# A bibliometric analysis of cleaner production in the floriculture sector in Colombia over the last 15 years

Un análisis bibliométrico sobre la producción más limpia en el sector floricultor en Colombia en lo últimos 15 años

**Helem Tatiana Vega Sánchez**
Master's Degree, Corporación universitaria Minuto de Dios, Bogota, Colombia
hvegasanche@uniminuto.edu.co
tatianavegasan@gmail.com
https://orcid.org/0000-0002-3388-7600

**Abstract**
The production and export of cut flowers is one of the main products of the agricultural sector in Colombia with 4,000 ha of production and an annual growth in exports, as well as the increasing requirements of the international market, therefore it is of great importance to achieve a suitable product through the improvement of processes and the incorporation of cleaner production techniques. The objective of this work is to analyze the scientific production in Colombia in relation to the rest of the world in the period 2005-2019, using the Scopus database filtering with the keywords "cut Flowers" "environmental" and "Colombia". The analysis was carried out using the VOSviewer® tool that allows observing the temporal trend of publications and the co-occurrence of keywords that emphasize sustainability and the implementation of good practices in the sector. The results of the search showed that Colombia has minimal participation in global access publications, so greater participation is required from academia and funded projects involving small producers so that they have access to research that promotes the improvement of their processes and access to new markets.
**Key words:** cleaner production, flowers, sustainability, bibliometrics.

**Resumen**
La producción y exportación de flores de corte es uno de los principales productos del sector agrícola en Colombia con 4.000 ha de producción y un crecimiento anual en exportación, así mismo aumentan los requerimientos del mercado internacional por lo tanto es de gran importancia conseguir un producto idóneo por medio del mejoramiento de procesos y la incorporación de técnicas de producción más limpia. El presente trabajo tiene como objetivo el análisis de la producción científica en Colombia con relación al resto del mundo en el periodo 2005-2019, empleando la base de datos Scopus filtrando con las palabras clave “cut Flowers” “environmental” y “Colombia”. El análisis se realizó utilizando la herramienta VOSviewer® que permite observar la tendencia temporal de las publicaciones y la co-ocurrencia de las palabras clave que tienen énfasis en la sostenibilidad y la implementación de buenas prácticas en el sector. En los documentos arrojados en la búsqueda, los resultados demostraron que Colombia tiene una mínima participación en las publicaciones de acceso mundial, por lo que se requiere


http://centrosuragraria.com/index.php/revista, Published by: Edwards Deming Institute, Quito - Ecuador, January - March vol. 1. Num. 12, 2022, This work is licensed under a Creative Commons License, Attribution-NonCommercial-ShareAlike 4.0 International. https://creativecommons.org/licenses/by-nc-sa/4.0/deed.es

Received January 09, 2021
Approved: July 12, 2021

mayor participación de la academia y de proyectos financiados en los que intervengan los pequeños productores para que tengan acceso a las investigaciones que promuevan el mejoramiento de sus procesos y el acceso a nuevos mercados.
**Palabras clave:** Producción más limpia, flores, sostenibilidad, bibliometría.

## Introduction

In the world market for cut flowers, this sector continues to grow, with the Netherlands being the main exporter of flowers with 45% of world exports, followed by Colombia with 16%, and finally Ecuador, Kenya and Belgium, which contribute 10, 8 and 3%, respectively, of total exports of flowers in the world Manrique et al. (2014). This increase demands high production requirements, but in relation to quality, demanded in different markets, involving plant breeding material, soil and substrate management, fertilizer use, phytosanitary products, harvesting, as well as post-harvest treatments (GlobalGAP, 2019).

In Colombia, the floriculture sector is one of the pillars of the economy, it is characterized by its great contributions to the development of the national economy represented in its high level in the GDP and a potential generator of employment (Gutiérrez and Almanza, 2016) the departments of Antioquia and Cundinamarca are attributed to be the main producers of cut flowers with more than 8,000 ha in production, as of 2015 with about 10.9% average annual growth in exports, and are concentrated in the savannah of Bogotá with 66% (Gonzalez et al., 2015; ICA, 2016; Vanegas and Restrepo, 2016; Lesmes and Binder, 2013).

Currently, with the evolution of markets, crops were diversified in order to increase competitiveness, which implies the export of more than 50 types of flowers and foliage. For 2016, rose represented 22% of the total exported, followed by pompon with 15%, carnation represented 14%, while foliages occupied 27% (CCB, 2016). This sector shows a strengthening process in the country, flower exports from Colombia reported US$75.5 million up to April 2018, with a volume of 14,415 t (Asocolflores, 2018) remaining as one of the first exporting countries despite the global oversupply and currently occupying the second place.

In the case of floriculture, sustainability is based on the efficient use of resources, where the concept of cleaner production (CP) is applicable. In every production system, waste is generated as a product of the processes of each system. CP is defined as the continuous application of preventive environmental strategies to processes, products and services in order to increase efficiency and minimize risks to human health and the environment (UNEP, 2006). Thus, the PML has a large number of benefits that contribute to the continuous improvement of the company, it contributes to support in different areas either in terms of production processes, products and services, in order to reduce costs, encourage innovations and reduce relevant risks to humans and the environment (Loayza and Silva, 2013, p. 110).

LWP favors the reduction of operating costs and risks, waste management, optimization of resource use, elimination/reduction of waste, effluents and emissions, improvement of plant

operational efficiency, energy efficiency, increases productivity and competitiveness with the improvement of the company's image Ferreria (2018). A constant evolution in the efficiency of production systems and government policies has enabled the control of the environmental impact of production activities and has encouraged companies to develop strategies to achieve more sustainable operations by modifying current production and consumption patterns (Minambiente, 2019).

Taking into account the environmental context, in recent years a growing awareness of sustainable production schemes and certified systems in agriculture emerged, and numerous scientific studies aimed at improving the environmental performance of these production processes have been carried out Parrado et al. (2019), the Colombian association of flower exporters, ASOCOLFORES, created the Florverde Sustainable Flowers certification program, as a tool that promotes social responsibility and seeks the adoption of good agricultural practices, minimization of the use of agrochemicals, protection of the fundamental rights of workers, product quality and managerial responsibility (ICONTEC, 2016), in addition, the importance of Rainforest Alliance, homologous with the guidelines of the secretariat of the Sustainable Agriculture Network that manages certification systems.

At present, the floricultural sector has adopted several techniques of good practices and LMP in its processes as certification requirements demand it, therefore, a research is proposed based on a descriptive bibliometric analysis, a methodology of quantitative analysis used with the purpose of studying the historical course of a field of knowledge from records such as periodical and non-periodical publications of the specialty (Cruz and Javela, 2004, p. 55).

This review document aims to show the evolution of PML in the flower sector in the world and in Colombia since 2005, in order to compare the studies carried out in Colombia with respect to the world, taking into account its economic importance worldwide in the export of cut flowers.

**Materials and methods**

With the purpose of searching for reliable and relevant information about the figures of cut flower productive systems that have implemented PML methodologies, examining the indicators to quantitatively express the bibliographic characteristics of a set of scientific publications, through the literature in order to study their nature and the course of their scientific discipline specifying the source of information and the variables for the application of the indicators (Arenas and Santillán, 2002; Camps, 2007; Rodriguez et *al.* , 2017).

The data were collected from the Scopus database, as it allowed eliminating duplicity of articles and scientific publications, ensured access to high quality research and worldwide consultation. The search was conducted with emphasis on articles, conference papers and book chapters in the English language from 2005 to 2019.

For the classification of the documents of interest, a terminological search was carried out based on the title, abstract and keywords. Two searches were performed (Fig. 1), the subject areas were limited to 'Agricultural and biological sciences' and 'environmental science'; the terms 'tomato' and 'pot plants' were then excluded from the search. The first search yielded 205 publications and the second yielded 20 publications.

**Table 1**. *Searches performed in Scopus, period 2005-2019.*

| FIRST SEARCH | SECOND SEARCH |
|---|---|
| **"cut flowers", "environmental"** | "cut flowers", "environmental", "Colombia". |

After performing the appropriate searches, the first analysis was performed according to Scopus statistics on the years in which articles or scientific papers are published, thus obtaining an analysis of the time trend. Following this, a knowledge mapping was performed, using as a tool the VOSviewer ® software (www.vosviewer.com) (Zhang et al., 2019; Raparelli and Bajocco, 2019), which allowed the construction and visualization of bibliometric networks. The analysis focused on the strength of connection and linkage between keywords in the papers that focused their studies on good agricultural practices in the floricultural sector.

With the search returned by the Scopus database, a complete count was performed on the result, this provided the following derivations: the time trend in the number of articles from 2005 to the present and the network of co-occurrence of keywords in the title, keywords and abstract fields of the publication; to ensure the consistency of the VOSviewer® mapping in the mapping, related terms or the same word in different languages were eliminated.

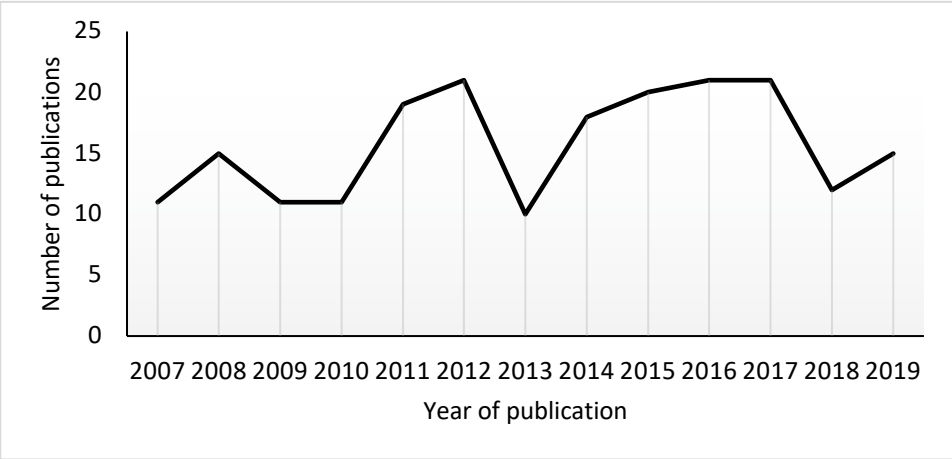
The mapping in the software was subdivided into data sets to analyze the evolution of cut flower research focused on sustainability over time, in addition, it allowed the analysis of the connections between the countries leading the research. To analyze the keywords, a coincidence analysis was performed, using a repetition number equal to 8 for the first search and 3 for the second search, i.e., the number of times a keyword must be present in the dataset used in the analysis.

## Result

Based on the themes of good agricultural practices, cleaner production and environmental management in the flower industry, the first search, focused on the number of publications made worldwide, shows that between 2014 and 2017 the largest number of publications

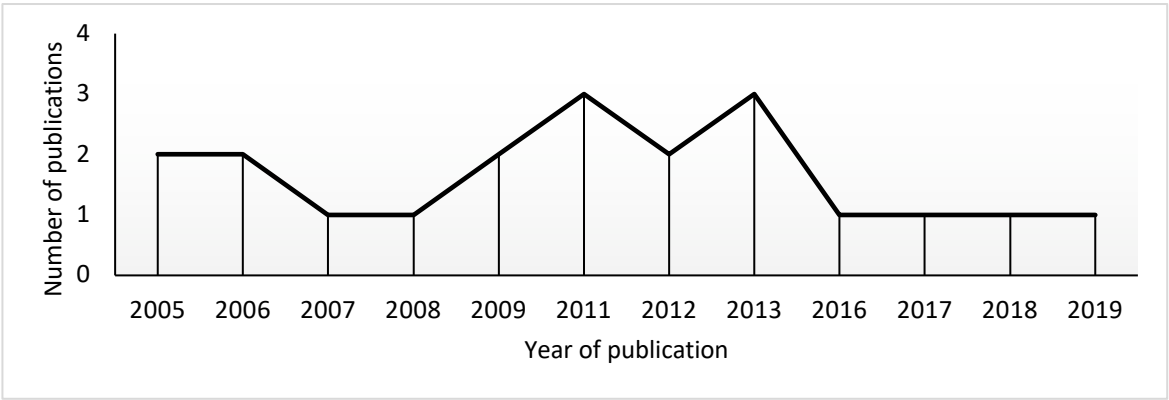
referring to LMP research was generated with a total of 80 documents (Fig. 2) and the second search focused on Colombia, shows that between 2008 and 2016 the largest number of publications was generated with a total of 12 documents (Fig. 1).

***Figure 1.*** Time trend of the number of publications resulting from the second search for publications with keywords "cut flowers", "environmental", period 2005-2019.




A comparison of the publications made by Colombia shows that they are a minority (9.7%) in relation to the publications made by other countries that are also aware of the importance of publishing the findings that can contribute to the improvement of this industry that can lead to the improvement of processes and sustainability; likewise, the number of indexed publications per year does not exceed 3 articles or books per year (Fig. 2).

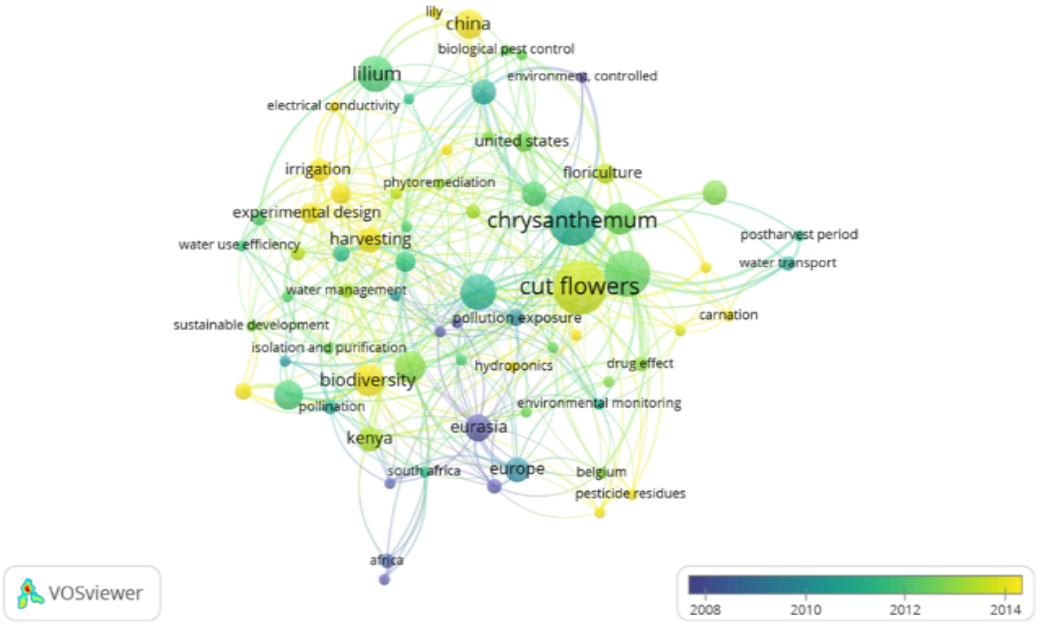
***Figure 2.*** Time trend of the number of publications resulting from the first search with the keywords "cut flowers" "environmental", "Colombia" in the period 2005-2019.



For the results of the first search (Fig. 4), a high correlation was found between the term "cut flowers" and the terms "hydroponics" "biological control" "water use efficiency" "environmental monitoring"; terms that are attributed to PML are related to pollution exposure, postharvest period, water use in plants (water transport) and the relevance of the research according to the species can be observed, finding that research towards environmental improvement in chrysanthemum is greater than in other species.

It is possible to observe the interaction of the experimental design, which has a close relationship with the studies on water use efficiency, harvesting processes, phytoremediation, bioremediation, biodiversity, pollination, soil analysis, biomass, which shows that they were researches with scientific rigor. When reviewing the relationship between cut flowers and sustainable development, different terms interact, such as nutrient management, irrigation, wastewater treatment, soil pollution management and biodiversity,

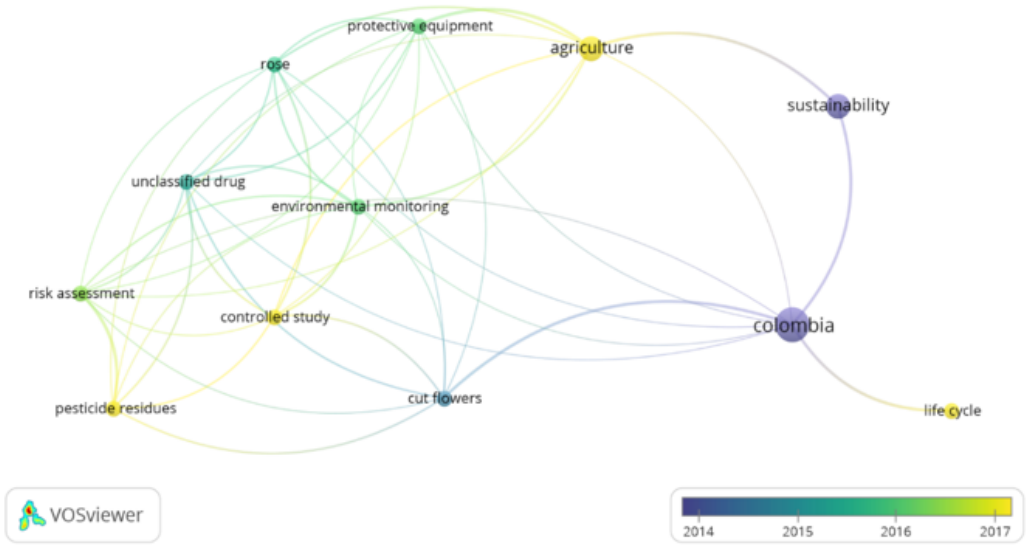
***Figure 3.*** Scientific mapping of the networks and correlation between the most used keywords in the first search focused on "cut flowers", "environmental", (2005-2019) Map generated by VOSviewer®.



The second search about the studies carried out in the country (Fig. 4), the analysis discriminates a relationship between Colombia, cut flowers, and sustainability, emphasizing the studies of environmental monitoring, life cycle as a methodology for environmental management; and terms related to good agricultural practices, among them, environmental monitoring, pesticide residues monitoring, risk assessment and personal protective equipment.

The importance of research on the relationship between Colombia, cut flowers and sustainability (sustainability) is evidenced from 2011 and 2016, where the highest peak of publications in the country is noted, followed by research items on risk assessment, protective equipment and environmental monitoring, reaching the most recent topic of pesticide residues monitoring.

***Figure 4.*** Scientific mapping of the networks and correlation between the most used keywords in the second search focused on "cut flowers", "environmental", "Colombia" (2005-2019). Map generated by VOSviewer®.




In this document, a bibliometric analysis was made on cleaner production in the flower sector, the search allowed the observation of the temporal trends of publications globally and in Colombia, articles and books were evaluated in the period 2005-2019. The research obtained in the search were topics related to environmental improvement and the implementation of

good agricultural practices techniques in the floriculture sector, the growing importance of the term sustainability in the production systems focused on this industry was observed, taking into account environmental responsibility and the high demands of consumers that are subject to certifications, a peak of publications is denoted between 2014 to 2017, which coincides with the creation of the UN Sustainable Development Goals in 2015 (UN, 2019) and the Paris agreement in 2015 that establishes measures for the reduction of greenhouse gases (European Commission, 2019).

The terms that are related in the mapping contribute to the improvement of the requirements for compliance with the standard requested by the sustainable agriculture network, initially imposed by "Florverde Sustainable Flowers" and with approvals at the social level with Rainforest Alliance and Global G.A.P. at the environmental level, among other seals of international relevance. Currently in Colombia there are 2,215 ha certified, which translates into about 40% of exports certified under this seal (Asocolflores, 2019).

In order to achieve sustainable agriculture, strategic alliances are built that allow the suitability of the product, such as certifications or seals, for example the Standard with indicators for Sustainable Agriculture - Sustainable Agriculture Network, which includes requirements such as: social and environmental management system, ecosystem conservation, wildlife protection, conservation of water resources, fair treatment and good conditions for workers, occupational health and safety, community relations, integrated crop management, soil management and conservation, integrated waste management, protocols such as the one mentioned above require high labor costs and infrastructure improvements.

Colombia's low participation in scientific production in this area is observed, especially considering that the flower industry is one of the most important sectors for the country's economy, so it is speculated that innovations and improvements in the processes become trade secrets of the companies that are dedicated to this purpose, Therefore, it is necessary to create more effective information channels so that the medium and small companies in the sector, as is the case of the producers of plants in matera, implement good practices in the production process and manage to reach new markets (García, 2019, p. 9).

**Conclusions**

The bibliometric analysis allowed the comparison of Colombia's international scientific production in relation to the world in terms of cleaner production in the floriculture sector based on the Scopus database, taking into account that Colombia is the second largest exporter of cut flowers and there is a need to comply with the quality requirements imposed by the market within the framework of sustainable production.

Scientific contributions on cleaner production in the floriculture sector around the world have shown a growing importance of research on the implementation of techniques that allow the improvement of processes in favor of the environment with topics related to biological control,

hydroponics, efficient use of resources, environmental monitoring, certification and practices that lead the floriculture industry towards sustainability.

In Colombia, research has been reported on the use of soil, substrates and implementation of good agricultural practices such as environmental risk monitoring, use of personal protection equipment and detection and mitigation of pesticide residues; however, there is a gap in research on pest and disease management, so it is recommended to focus studies in this area. Contrary to expectations, the country's worldwide scientific publications have a low participation margin with respect to the rest of the world, a maximum of three publications per year, so greater involvement of academia is required, as well as greater financing of projects by the government to allow participation and access to small and medium-sized producers to improve processes and product quality.

**References**

Álvarez, C., Acevedo, C. Hernández, S. Piedrahita, J. (2007). Agro-environmental management and certification: the road to sustainability in floriculture. Line of research: Environmental management. SIGMA research group and GAMA Research Group. *Corporación Universitaria Lasallista.* pp. 68-87.

Arenas, J., and Santillán, E. (2002) Bibliometrics, for what? Instituto de Investigaciones Biomédicas, *Universidad Nacional Autónoma de México (UNAM)*, Ciudad Universitaria, Mexico City, Mexico, 5(1), pp. 1-10.

ASOCOLFLORES. (2018) Statistical bulletin April 2018. *Colombian Association of flower exports* pp. 1-47.

ASOCOLFLORES (2019) Sustainability: What are we doing for our associates? Retrieved from https://asocolflores.org/es/category/pilares-de-gestion/sostenibilidad/

Chamber of Commerce of Bogotá (2015) Agricultural and agroindustrial support program vice-presidency of business strengthening chamber of commerce of Bogota. pp. 1-41.

Camps, D. (2007) General bibliometric study of collaboration and information consumption in original articles of the journal Universitas Médica, period 2002 to 2006. *Pontificia Universidad Javeriana. 48 (4). 2007.* pp. 358-365.

EUROPEAN COMMISSION. (2019) Paris Agreement. https://ec.europa.eu/clima/policies/international/negotiations/paris_es

Cruz, J., and Javela, L. 2004. An approach to the dominant paradigm of social psychology based on a sample of manuals published since 2000. *Catholic University of Colombia.* Acta Colombiana de Psicología (12) 2004. pp. 39-58.

ICONTEC. (2016) FLORVERDE Sustainable Flowers Certification. Retrieved from https://www.icontec.org/eval_conformidad/certificacion-florverde%E2%80%8B/

García, D. (2019) Case analysis: development of sustainable production programs for the Colombian flower sector in the last two years. Semillero de Investigación Desarrollo Sostenible Fundación *Universitaria de la Cámara de Comercio de Bogotá Finance and Foreign Trade Program*. pp. 1-10.

GLOBALGAP. (2019) GLOBALG.A.P. Standard for Flowers and Ornamentals. Retrieved from https://www.globalgap.org/es/for-producers/globalg.a.p./integrated-farm-assurance-ifa/crops/FO/

González, E., Orjuela, J. Trujillo, M. Becerra, J. (2014) Description of the flower production chain in the Bogotá and Cundinamarca area. Semilleros, 1 (1), pp. 5-16.

Gutiérrez, R., Almanza, C. (2016) An approach to the competitive characterization of the industrial and floricultural productive sectors of the municipality of Madrid Cundinamarca, Colombia. Doi: http://dx.doi.org/10.1016/j.sumneg.2016.02.006

ICA. (2017) In Antioquia, ICA socializes sanitary regulations for flower exports. Retrieved from https://www.ica.gov.co/movil/noticias/7475.aspx

Lesmes, C., Binder, C. (2013) Pesticide Flow Analysis to Assess Human Exposure in Greenhouse Flower Production in Colombia. Department of Geography, Ludwig Maximilian *University of Munich. International Journal of Environmental Research and Public Health*. pp. 1169-1180. www.mdpi.com/journal/ijerph

Loayza, J., Silva, V. (2013) Sustainable industrial processes and their contribution to the prevention of environmental problems. UNMSM. Journal of the faculty of industrial engineering. 16(1): pp. 108-117.

Ministry of environment and sustainable development. (2019) Sustainable production and consumption. Retrieved from http://www.minambiente.gov.co/index.php/component/content/article/154-plantillaasuntos-ambientales-y-sectorial-y-urbana-7

UN. (2019) Sustainable Development Goals. Retreived from https://www.un.org/sustainabledevelopment/es/

Parrado, C., Ricardo, H. Velásquez, S. Lopera, C. Hasenstab, R. (2019) An Environmental Evaluation of the Cut-Flower Supply Chain (Dendranthema grandiflora) Through a Life Cycle Assessment. *EIA Journal*, ISSN 1794-1237. 16 (31), pp. 27-42.

Raparelli, E., Bajocco, S. (2019) A bibliometric analysis on the use of unmanned aerial vehicles in agricultural and forestry studies. *Council for Agricultural Research and Economics, Research Centre on Agriculture and Environment*, CREA-AA, Rome, Italy. pp. 1-11.

UNEP, (2011) Environmental agreements and Cleaner Production. Division of Technology, Industry & Economics In co-operation with InWEnt pp. 1-21.

Vanegas, J., Restrepo, J. (2016) Factors affecting the positioning of products abroad: the case of the Antioquian floricultural sector. *Sergio Arboleda University.* 16 (30). January-June, 2016, pp. 145-160.

Zhang, X., Estoque, H. Xie, Y. Murayama, M. Ranagalage, R. (2019) Bibliometric analysis of highly cited articles on ecosystem services. PLoS ONE 14 (2): e0210707. D https://doi.org/10.1371/ journal.pone.0210707.