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Ecological, economic and social impacts of the Colombian cocoa sector

Impactos ecológicos, económicos y sociales del sector cacaotero Colombiano

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Abstract

Due to its excellent quality, Colombian cocoa has become a product that has made considerable inroads in the national and international market, increasing its demand and the effects inherent to its production practices. This scope review was carried out following the guidelines of the *Joanna Briggs Institute* (JBI), which allowed the selection of 72 documents, whose information extraction led to the identification and standardization of the economic, ecological and social impacts of the cocoa sector in the different producing cities of Colombia, of which Santander, Antioquia, Arauca, Huila and Tolima stand out since they generate 70% of the cocoa production at the national level. In the review, a total of 13 social, 25 ecological and 21 economic impacts are clearly observed, which correspond to the most persistent impacts evidenced in the different investigations carried out in this country.

Keywords: impact, cocoa, Colombia, producers

Resumen

El cacao colombiano, debido a su excelente calidad, se ha convertido en un producto que ha incursionado de manera considerable en el mercado nacional e internacional, lo que ha incrementado su demanda y con ello los efectos inherentes a sus prácticas productivas. Esta revisión de alcance se realizó siguiendo las orientaciones del *Joanna Briggs Institute* (JBI), lo que permitió la selección de 72 documentos, cuya extracción de información condujo a la identificación y homologación de los impactos económicos, ecológicos y sociales del sector cacaotero en los diferentes departamentos

productores de Colombia, de los cuales destacan los departamentos de Santander, Antioquia, Arauca, Huila y Tolima, quienes generan el 70% de la producción de cacao a nivel nacional. En la revisión, se observa claramente un total de 13 impactos sociales, 25 ecológicos y 21 económicos, que corresponden a los impactos más persistentes evidenciados en las diferentes investigaciones desarrolladas en este país.

Palabras clave: impacto, cacao, Colombia, productores

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1 Introduction

Global agriculture is growing with the increasing population, which drives a rise in the demand for products that ensure the availability of safe and nutritious food. Cocoa is a fundamental and extremely important product in global agriculture, due to its numerous derivatives and products manufactured from it. Africa dominates the market with 77% of global production, followed by Latin America, where the global production of cocoa beans is 17% (International Cocoa Organization, 2019). Colombian cocoa stands out for its high quality, aroma, and flavor, ranking tenth in the world after the Dominican Republic, with a production of 63,416 tons in 2020, of which 11,148 tons were exported (Cataño, 2019; Baquero, 2021).

African countries, such as Côte d'Ivoire and Ghana, are the world's leading cocoa producers, followed by South American countries like Ecuador and Brazil (International Cocoa Organization, 2021). However, cocoa production, like any other agricultural production, generates adverse environmental effects. For instance, in Côte d'Ivoire, only 4% of its territory remains covered with tropical rainforest, and in 13 of its 23 protected areas, the populations of primates and elephants have completely disappeared. According to the NGO Mighty Earth, one of the main reasons for this is the expansion of cocoa cultivation fields (Claus et al., 2018; Jagoret et al., 2020). In Ghana, alternatives such as climate-smart agriculture, whose objectives are climate change mitigation and adaptation and food security, pose a threat of inequity to small producers while favoring multinational dominance (Taylor, 2018; Maas et al., 2020; Nasser et al., 2020). These data are truly alarming and require urgent intervention due to the significant impact the cocoa sector is causing not only in Africa but globally.

Garmendia et al. (2005) and Mereddy et al. (2017) define environmental impact as the alteration of environmental quality generated by anthropogenic activities, both directly and indirectly. Generally, these impacts are evaluated from ecological and socioeconomic perspectives, measuring changes in individual well-being as long as these can be attributed to an activity, project, or policy as a causal relationship (Gertler et al., 2017). This makes impact assessment a priority component for the development and implementation of sustainable agriculture, ensuring food production and distribution, and restoring natural resources (Bergez et al., 2022; Kross et al., 2022).

Studies conducted by Schroth et al. (2011); Braga et al. (2019); Rocha et al. (2019) in Brazil, and Hands (2021) in other Latin American countries indicate that only through production by small farmers with reduced agricultural management in a forest landscape (agroforestry) can the normalcy of ecosystem services and the conservation of wild communities be guaranteed. According to studies conducted by Brito et al. (2018) and Rooduijn et al. (2018) in Mexico, cocoa production in agroecosystems positively involves carbon sequestration, reduction of greenhouse gas emissions, soil fertility and biodiversity, and water quality. Similarly, studies conducted in Bolivia by Armengot et al. (2017) and Chumacero et al. (2018) describe the impacts of cocoa production on biodiversity according to the farming system and diversification of farm production, although also noting adverse socioeconomic aspects such as lack of access to credit, increased labor, and consequently, increased production costs.

Several studies have been conducted on the Colombian cocoa sector in different producing cities, but none provide sufficiently clear national data on the environmental impact of this sector, which is so important to the Colombian economy. The objective of this review is to identify the ecological, economic, and social impacts generated by cocoa cultivation in Colombia, based on the frequency of mention in studies related to cocoa cultivation in this territory.

2 Methodology

The procedure for conducting this review followed the guidelines proposed by the *Joanna Briggs Institute* (JBI) (Peters et al., 2015, 2020) and the *Preferred Reporting Items for Systematic review and Meta-Analyses extension for Scoping Reviews* (PRISMA-ScR) (Tricco et al., 2018).

2.1 Study Selection

The selection process for sources of evidence included three phases that defined the studies to be reviewed for extracting information. These phases co-

rrespond to the identification of sources of evidence and studies, the review and search strategies, and the eligibility of documents for obtaining and analyzing information according to the defined selection criteria.

2.2 Identification of Sources of Evidence

Based on the review question defined as "What is the environmental impact generated by cocoa agricultural production in Colombia?" the objective was to review the positive and negative impacts at the ecological, economic, and social levels of cocoa production in Colombia. Due to its inclusive nature, the review is classified as a scoping review according to Munn et al. (2022), allowing for the extension or broadening of the nature of the documents to be studied in particular contexts, identifying various evidence and limitations of the existing information (Pollock et al., 2022). Given the limited abundance of publications on this topic, the review included scientific articles from specialized journals, undergraduate and postgraduate theses (master's and doctoral), institutional documents regardless of the methodological approach, and conference abstracts.

2.3 Search Strategies

The Colombian cities with significant cocoa influence were identified, and the level of studies conducted in these influential cocoa regions of the country was reviewed, including the applied research approaches and methodologies. During the search and data collection, repositories from different university libraries and documents from the National Federation of Cocoa Growers (FEDECACAO) were consulted, and the following databases were used: *Proquest, IFPRI, Redalyc, Sage, Science Direct, AGRIS, Google Scholar, Springer Journal, Scielo*. The search was conducted using the following keywords and Boolean operators: economic impacts, social impacts, ecological impacts, certification, cocoa culture, cocoa, to obtain documents related to the information analysis. The search equation used was (economic impacts OR social impacts OR ecological impacts) AND (cocoa OR ≪cocoa culture≫) AND (Colombia), and searches were also conducted including the keywords in the equation in both English and Spanish followed by "", "$" and ().tw. This strategy yielded 182 records along with three unpublished institutional documents, from which 109 were filtered out after removing duplicates.

2.4 Eligibility and Inclusion

The potential sources of evidence were fully downloaded and evaluated by at least two reviewers following the inclusion criteria presented below:

- Published as articles in scientific journals, books, undergraduate and postgraduate theses.
- Written in English or Spanish.
- Published between the years 2000 and 2020.
- Studies evaluating the Colombian territory.
- Studies covering topics related to cocoa only.

Disagreements among the reviewers during the selection process were resolved with an additional reviewer. After the evaluation, a total of 72 documents with the necessary characteristics were identified for their inclusion in this study. These included 51 peer-reviewed articles, 17 theses, 1 symposium report, and 3 institutional documents. The selection process is shown in Figure 1 with the records identified at each phase through a PRISMA flow diagram.

2.5 Data Extraction and Processing

The impacts cited in these publications were recorded in a matrix for classification, standardization, and frequency determination of citations. As the process is iterative, the matrix was refined during data extraction. Finally, the matrix for data recording included study characteristics such as source category and origin, publication year, author details, title, keywords, study area, sample, research methodological design, environmental impacts by category, and description of the impact. With the data condensed in the table, the most studied regions of the country on this topic were defined, the most frequent methodological designs were identified, and the various impacts were standardized according to the authors' descriptions.

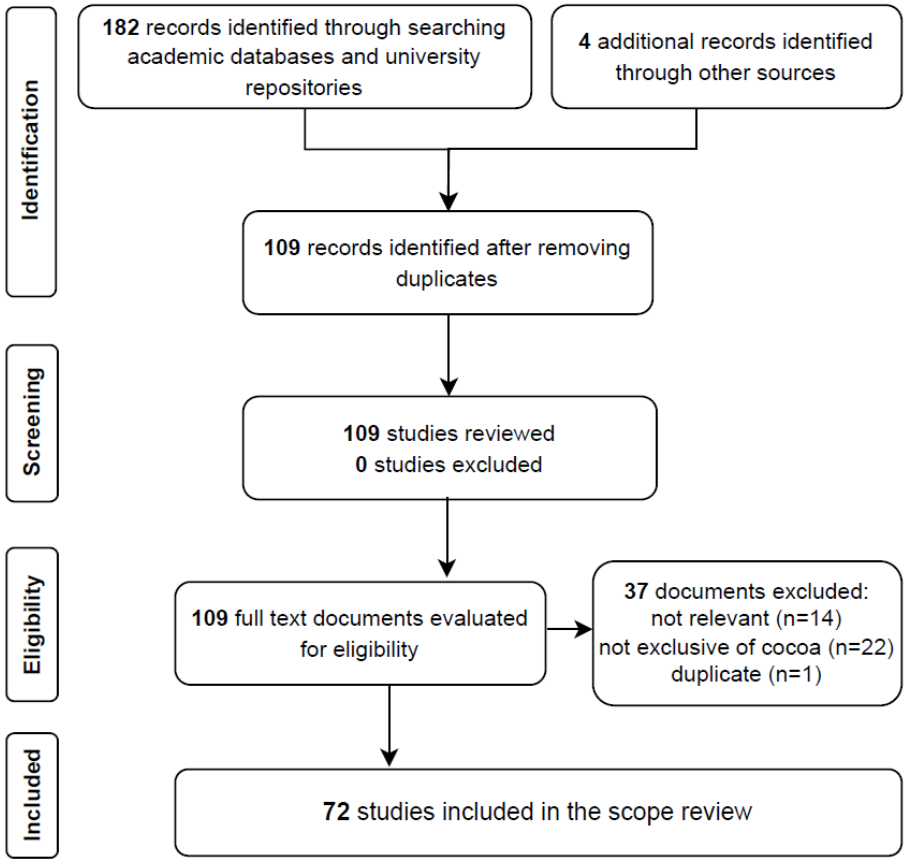

Figure 1. PRISMA flowchart with scoping review study selection process.

3 Results

3.1 Cocoa-Producing states in Colombia

In the review, thirty (30) Colombian cocoa-producing states were identified as having significant participation in the sector. Moreover, it was evident that five (5) of these states have the highest percentage of national production, as highlighted in Table 1: Santander, Antioquia, Arauca, Huila, and Tolima, which collectively account for 72% of the country's cocoa production. Santander stands out as the most influential, contributing 42% of Colombian cocoa production (Fedecacao, 2019).

Table 1. Major cocoa producers in Colombia, production quantity, cultivated area and percentage share in the Colombian market.

State	Production (t)	Production (%)	Cultivated Area (ha)	National Cultivated Area (%)
Santander	25158	42	73699.20	42.11
Antioquia	5259	9	15406.00	8.80
Arauca	4546	8	13317.30	7.61
Huila	4051	7	11867.22	6.78
Tolima	3928	7	11506.89	6.58

3.2 Most Evaluated Cocoa-Producing states

The 72 studies reviewed in this research are distributed across 18 states in Colombia (Table 2). Nearly 70% of these studies focus on Santander (27.1%), Norte de Santander (17.1%), Antioquia, and Huila (11.4% each). It is noteworthy that several of the selected documents mentioned more than one state within their study areas.

Table 2. Cocoa growing states with the highest frequency of occurrence.

State	Frecuency
Santander	19
Norte de Santander	12
Antioquia	8
Huila	8
Arauca	6
Cundinamarca	6
Nariño	5
Meta	4
Tolima	3
Cesar	3
Boyacá	3
Caquetá	2
Valle del cauca	2
Caldas	1
Bolívar	1
Guaviare	1
Vichada	1
Amazonas	1

3.3 Methodological Approaches Employed in the Analyzed Studies

During the review of the selected documents, information was obtained to determine the methodologies employed by the authors in their investigations (Table 3). It was identified that the predominant methodology in these studies is mixed-methods research, with a frequency of 70% among the selected studies. Additionally, it was noted that some documents did not clearly state their research methodology.

Table 3. Methodologies used in the studies analyzed in this review.

Methodologies used	Frecuency
Qualitative	7
Quantitative	14
Mixed	49
The methodological approach is not indicated or is not clear	2
Total	72

3.4 Ecological Impacts

The impacts most frequently identified in the review were ecological, with 14 positive and 11 negative impacts named in 56 out of the 72 selected documents. It is important to clarify that many studies reported overlapping impacts; thus, Table 4 presents the impact and the frequency with which it was referenced.

The increase in measures aimed at protecting biological diversity is the most frequently mentioned impact by the authors of the selected studies (Ramírez et al., 2014; Gutierrez et al., 2015; Agudelo, 2016; Suárez, 2018; Cubillos, 2017; Hernández et al., 2018; Naranjo et al., 2017; Ordoñez, 2019). These studies indicate the relationship of this impact with environmental awareness within the Colombian cocoa sector and various public and private entities that direct efforts towards sustainable productivity and the protection of the diversity of plant and animal species inhabiting these spaces, especially when cultivation is small-scale and conducted within appropriate agroforestry systems (Zoe et al., 2018).

The second most replicated impact in the review was the increased application of pesticides in cocoa crops (Ortiz et al., 2016; Vásquez et al., 2018; González et al., 2018; Ferro and Meneses, 1996; Sánchez and Gamboa, 2014; García-Cáceres et al., 2014). This can cause health issues for individuals directly and indirectly exposed to such substances, resulting in increased infections and diseases in humans (Montoya et al., 2015; Villamizar et al., 2016). Furthermore, the lack of knowledge among cocoa farmers regarding pesticide application leads to significant crop losses due to inefficient protocols and controls, affecting production yields and increasing soil contamination (Torrente, 2016).

Table 4. Ecological impacts of cocoa farming in Colombia.

Impacts	Type	Frequency	% citations
Increased measures aimed at biodiversity protection	Positive impact	33	22.15
Increased pesticide application on cocoa crops	Negative impact	18	12.08
Decrease in good agricultural practices (GAP)	Negative impact	8	5.37
Increased contamination of water resources	Negative impact	7	4.7
Reduction in carbon dioxide emissions	Positive impact	7	4.7
Increased soil conservation measures	Positive impact	7	4.7
Increased soil yields	Positive impact	7	4.7
Increased air pollution	Negative impact	6	4.03
Decrease in the contamination of water resources	Positive impact	6	4.03
Increased nutrient alteration of soils by using artificial components	Negative impact	5	3.36
Increased investment in the improvement of food safety, phytosanitary management and international certifications.	Positive impact	5	3.36
Increased landscape modification	Negative impact	5	3.36
Increase in the impact on biodiversity	Negative impact	5	3.36
Increased conservation of water resources	Positive impact	4	2.68
Increased use of environmentally friendly fertilizers	Positive impact	4	2.68
Increased adaptability to climate change	Positive impact	4	2.68
Decrease in the use of artificial fertilizers	Positive impact	3	2.01
Decrease in the use of pesticides	Positive impact	3	2.01
Increase in human infections and pests	Negative impact	3	2.01
Increase in shade plantings	Negative impact	2	1.34
Decrease in logging of forests and jungles	Positive impact	2	1.34
Reduction of forest fires	Positive impact	2	1.34
Increase in greenhouse gases	Negative impact	1	0.67
Decrease in water resources	Negative impact	1	0.67
Increased utilization of wastes	Positive impact	1	0.67

The third impact identified was the decline in good agricultural practices (GAP) (Ferro and Meneses, 1996; Sánchez and Gamboa, 2014; Arias et al., 2016; Contreras, 2014; Ramírez et al., 2014). It is noted that the Colombian cocoa sector becomes negligent when their cocoa lacks certification, directly affecting processes related to safety, quality, and production. This impact also leads to an increase in landscape modification (Ruiz, 2014; Ramírez et al., 2014; Espinoza and Ríos, 2016; Carrillo, 2017; Correa, 2017; Caviedes and Olaya, 2020) and biodiversity loss (Montoya et al., 2015; González et al., 2018; Rodríguez et al., 2017; Carrillo, 2017; Correa, 2017) due to non-compliance with necessary protocols for proper agricultural practices. This negligence is also due to the cocoa sector's disinterest, knowing that the lack of certification directly affects their income.

The fourth impact identified during the review is the increase in contamination of water resources (Montoya et al., 2015; Ferro and Meneses, 1996; Ramírez et al., 2014; Ramos et al., 2016; Correa, 2017). This analysis indicates that, in addition to soil impacts, poor agricultural practices are indirectly affecting water sources near the planting areas, causing significant damage to the diversity of species that inhabit these areas and rely on this resource. This can lead to reduced water flow (Montoya et al., 2015).

3.5 Economic Impacts

It was evident that economic impact records were mentioned in more than 70% of the reviewed documents, with 14 positive impacts and 7 negative

impacts identified. Their frequency and percentage of occurrence are presented in Table 5.

The most frequently noted impact was the decreased profitability of conventional cocoa due to the expansion of certified cocoa production (Pedroza, 2012; Rangel et al., 2013; Sánchez and Gamboa, 2014; García-Cáceres et al., 2014; Arias et al., 2016; Ortiz, 2015). Cocoa farmers tend to produce lower-quality cocoa with lower investment without certification to ensure product quality. However, the second most frequently noted impact was the improvement in cocoa quality (Carrillo et al., 2014; Plazas et al., 2017; Machado et al., 2018; Suárez, 2018; Barragán and Rey, 2004).

Table 5. Economic impacts of cocoa farming in Colombia.

Impacts	Type	Frequency	% citations
Decrease in the profitability of conventional cocoa due to the expansion in the generation of certified cocoa.	Negative impact	23	18.55
Cocoa quality improvement	Positive impact	16	12.9
Cocoa sector market development	Positive impact	14	11.29
Increasing programs and project initiatives in the cocoa sector	Positive impact	12	9.68
Decrease in investment interest in the cocoa sector	Negative impact	9	7.26
Increase in cocoa growers' and cocoa entrepreneurs' confederations	Positive impact	6	4.84
Increased production in the cocoa sector	Positive impact	6	4.84
Increase in disputes between certification programs	Positive impact	5	4.03
Increase in the evolution and technological progress of the cocoa sector.	Positive impact	5	4.03
Increased economic progress and development in the region	Positive impact	5	4.03
Decrease in certified cocoa	Negative impact	4	3.23
Expansion of the cocoa sector	Negative impact	3	2.42
Increased economic dependence of the population on the cocoa sector	Negative impact	3	2.42
Increased compliance with domestic regulations	Positive impact	3	2.42
Increased support and sponsorship from national and international organizations	Positive impact	2	1.61
Increase in the price of the product	Positive impact	2	1.61
Decrease in production quotation	Positive impact	2	1.61
Increased access to investment loan securities	Positive impact	1	0.81
Increased production costs	Negative impact	1	0.81
Increase in the replacement of cocoa with other crops	Negative impact	1	0.81
Decrease in consumption and acquisition of external inputs	Positive impact	1	0.81

The third most frequent impact was the increase in the cocoa sector market (Rojas et al., 2008; Jaimes et al., 2011; Arias et al., 2016; Ramírez et al., 2014; Arias et al., 2016; Osorio et al., 2017). This impact is parallel to the increased production in the cocoa sector (Correa et al., 2014; Álvarez et al., 2015; Montoya et al., 2015; Plazas et al., 2017; Cely, 2017), driven by high international recognition and increased market demand, generating profitability and increased trade in the sector (Correa et al., 2014; Álvarez et al., 2015; Montoya et al., 2015; Plazas et al., 2017; Cely, 2017). This has led to the formation of cocoa producers and entrepreneurs' confederations (Barragán and Rey, 2004; Unión Europea, Ministerio de Comercio, Industria y Turismo, 2011; Sánchez and Gamboa, 2014; Gutiérrez et al., 2020), granting prestige and credibility to this activity in the region. Generally, this contributes to economic progress and development in the region (Rodríguez, 2011; Unión Europea, Ministerio de Comercio, In-

dustria y Turismo, 2011; Pabón et al., 2016; Ortiz et al., 2016; Cataño, 2019). In some regions, economic dependency on the cocoa sector has been observed (García-Cáceres et al., 2014; Cardona et al., 2016; González et al., 2018).

The fourth most predominant impact in the reviewed studies is the increase in programs and project initiatives in the cocoa sector (Forero et al., 2015; Rodríguez, 2017; Suárez, 2018; Unión Europea, Ministerio de Comercio, Industria y Turismo, 2011; Correa et al., 2014; Ruiz, 2014). These programs leverage acquired knowledge to improve planning and resource management, facilitating the optimal development of projects aimed at increasing cocoa productivity. However, the fifth most referenced impact indicates that investment interest in the cocoa sector has declined (García et al., 2012; Rodríguez et al., 2017; Oliveros, 2013; Contreras, 2014; Morillo et al., 2014; Cardona et al., 2016; Contreras, 2017; Rodríguez, 2017), due to low quality and productivity in some regions.

3.6 Social Impacts

The number of social impacts was the smallest, with 10 positive and 3 negative impacts, appearing in more than 50% of the reviewed documents. Table 6 presents the frequency and percentage of reference for each impact.

The main social impact identified by the authors of the reviewed documents was the increase in training and educational programs in the cocoa sector (Unión Europea, Ministerio de Comercio, Industria y Turismo, 2011; Sánchez and Gamboa, 2014; Morillo et al., 2014; Montoya et al., 2015; Ortiz, 2015; Pabón et al., 2016). This involves entities sending qualified personnel who share their knowledge with producers to assist in the development and maintenance of crops, thereby revitalizing the regional economy (Barragán and Rey, 2004; Sánchez and Gamboa, 2014; Arias et al., 2016; Vásquez et al., 2018).

Closely related to this, the second most referenced impact was the increase in research alternatives (Cleves et al., 2013; Forero et al., 2015; Ramos, 2014; Morillo et al., 2014; Cubillos, 2017; Plazas et al., 2017; Rodríguez, 2017). These are aimed at improving productivity, working conditions, and agro-industrial processes for cocoa transformation.

Table 6. Social impacts of cocoa farming in Colombia.

Impacts	Type	Frequency	% citations
Increased teaching and training procedures in the cocoa sector	Positive impact	12	23
Increase in research alternatives	Positive impact	7	13
Increased labor conditions for cocoa farmers	Positive impact	7	13
Increase in jobs	Positive impact	6	11
Reduction of poverty in the rural sector	Positive impact	4	8
Decrease in illicit crop production	Positive impact	4	8
Knowledge application and wage improvement	Positive impact	3	6
Consolidation of the cocoa sector culture	Positive impact	3	6
Inequity among cocoa sector producers	Negative impact	2	4
Reduction in the occupation of children in the labor sector	Positive impact	2	4
Increase in school absenteeism	Negative impact	1	2
Decrease in jobs	Negative impact	1	2
Increasing the involvement of women in cocoa sector activities	Positive impact	1	2

The improvement of working conditions for cocoa farmers was the third most frequently recorded social impact (Rodríguez, 2011; Fiallo, 2014; Parrado and Torres, 2017; Diaz and Sierra, 2018; Cataño, 2019; Velásquez, 2019; Vásquez et al., 2018). This not only allows farmers access to the benefits of farming machinery but also supports families by helping them initiate or continue their studies, gradually reducing child labor (Rodríguez, 2011; Rangel et al., 2013).

The fourth most frequently recorded impact in the reviewed documents is the increase in job opportunities due to high market demand, which requires a larger workforce during production (Rangel et al., 2013; Ramos et al., 2016; Vásquez et al., 2018; González et al., 2018; Correa, 2017; Cely, 2017). The increase in employment generated by cocoa cultivation in many regions has led to improved wages, greater purchasing power, and contributed to the reduction of rural poverty (Trujillo and Perdomo, 2016; Ortiz et al., 2016; González et al., 2018; Cataño, 2019; Jaimes et al., 2011; Correa et al., 2014; Suárez, 2018). This aspect even contributes to conflict resolution, as being a legal crop, cocoa has presented as an alternative to illicit crops (Vásquez et al., 2018; Suárez, 2018).

4 Conclusions

The available studies documenting the environmental impacts generated by cocoa farming in Colombia are limited in number. It was found that ecological and economic aspects are the most frequently described, while the social aspect is addressed in only 50% of the available documents. However, regarding the negative impacts generated by this activity, social impacts are significantly less identified than ecological and economic ones.

Considering cocoa as a raw material, the transformation process is basic, and its commercialization is closely tied to market price variations. Therefore, it is imperative that the respective support policies for cocoa farmers encourage the implementation of new strategies to differentiate the product in the market. This can be achieved through origin demarcations, type of cocoa, city and country of production, and quality standards in production processes, given that Colombia is one of the strongest and most significant cocoa-consuming industries. Such support focuses on development within local institutions.

It is evident that an excellent and robust product articulation in the market is necessary, alongside the creation of good business alliances for strategy development and the establishment of strong governmental relationships to secure capital support. Considering that to initiate these activities, it is necessary to commercialize cocoa beans with support and interventions aimed at improving the infrastructure of storage centers, enabling better control of product volume and quality by implementing internal control systems directed at obtaining or adopting certification programs.

Finally, organizational pilot projects should be undertaken to initiate a quality production process, thereby improving the quality of life of cocoa farmers through these new financial models. This approach aims at participation in local and international organizations that support farmer integrity, intervening not only in cultivation but also in economic and social aspects.

The findings of this review provide a master list and baseline available to the scientific community for future environmental impact studies. Additionally, this information can be used in the formulation of evidence-based public policies and as support for planning impact assessments of different programs or policy modalities that are implemented or intended to be implemented, aimed at supporting cocoa farmers in Colombia.

Author contribution

D.I.C.R.: Conceptualization, Research, Writing- reviewing and editing, Supervision; F.E.P.G.: Research, data processing, Writing- original draft; K.C.A.V: Conceptualization, Methodology, Validation, Visualization.

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