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Certifications and sustainability initiatives in the coffee sector: An analysis from the environmental audit in the department of Caldas, Colombia

Certificaciones e iniciativas de sostenibilidad en el sector cafetero: un análisis desde la auditoría ambiental en el departamento de Caldas, Colombia

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Abstract

This study discusses the performance of certifications and sustainability initiatives in coffee production in some municipalities of the department of Caldas, Colombia. It is carried out from the environmental audit approach for the benefit of agricultural production, through organizational practices that impact the economic, social and environmental conditions of the productive units. The article presents a Synthetic Sustainability Index estimated for 49 farms, an overview of the quality certifications, and codes of conduct that have been implemented in the region, based on the criteria of quality in production, marketing, environmental performance, productive organization and social conditions. The results show that environmental auditing can be a way to reduce imbalances in agricultural exploitation, in which the economic paradigm is equated with social challenges and care for ecosystems as a way to ensure the sustainability of resources, reduce poverty, and improve competitiveness and living conditions in the rural sector

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Resumen

Este estudio realiza una discusión sobre el desempeño de las certificaciones e iniciativas de sostenibilidad en la producción de café en algunos municipios del departamento de Caldas, Colombia, desde el enfoque de auditoría ambiental a favor de la producción agrícola, mediante prácticas organizacionales que impactan las condiciones económicas, sociales y ambientales de las unidades productivas. Para esto se presenta un Índice Sintético de Sostenibilidad estimado para 49 fincas, un panorama de las certificaciones de calidad y los códigos de conducta que se han implementado en la región, revisando los criterios de calidad en la producción, la comercialización, el desempeño ambiental, la organización productiva y las condiciones sociales. Se concluye que la auditoría ambiental puede ser un camino para reducir desequilibrios en la explotación agrícola, en la que el paradigma económico se iguala a los desafíos sociales y al cuidado de los ecosistemas como una forma de asegurar la sustentabilidad de los recursos, reducir la pobreza, mejorar la competitividad y en general las condiciones de vida del sector rural.

Código JEL: M42, Q01, Q56
Palabras clave: auditoría; desarrollo sostenible; producción y organizaciones; cafés especiales

Introduction

Transformations in the modes of production and consumption have generated a series of impacts on the environment, evident in pollution, the exploitation of non-renewable resources, the climate change crisis, and the ecological footprint, among other aspects (Sharma *et al.*, 2021). Nevertheless, the discourse of sustainable development has made possible the emergence of a series of environmental management initiatives, which have materialized through different types of quality certifications endorsed by international organizations, and some promoted by government policies. These initiatives stimulate the reconversion of productive processes that favor sustainability from a social and human point of view and in environmental care and preservation (Hummels & Argyrou, 2021; Ponte, 2020).

In Colombia, some organizations voluntarily implement audited sustainable processes (Mejía, 2011). Nonetheless, a transformation in the culture is needed to take advantage of the benefits that can be derived from its proper management and to respond to different aspects related to the country's productive structure and competitiveness. In the case of the coffee industry, processes of productive transformation have been developed that strengthen the production of coffee to guarantee the quality of different types of coffee that are cultivated in some regions, which have begun to be recognized as specialty coffees, given

that they meet a series of characteristics established by quality standards. These initiatives result from several national organizations such as coffee institutions, private companies, and some farmers' associations. They aim to improve the sector's competitiveness throughout the production chain and promote the social, environmental, and economic development of the coffee-growing region of Colombia.

This paper reflects on the role of certification and environmental auditing in coffee production methods in Caldas, Colombia, within the sustainability framework. It begins with a review of environmental auditing from the perspective of sustainable development and subsequently analyzes the characteristics of different certifications and quality controls that have been promoted in the Colombian coffee sector as an integrated growth strategy. Subsequently, a Synthetic Index is used to estimate the sustainability conditions in the technical, economic, social, and environmental dimensions for 49 coffee production units in the northern and eastern sub-regions of the Department of Caldas. Finally, some considerations are made regarding the role of sustainability initiatives and certifications and audits for the growth and competitiveness of the coffee industry in Colombia.

Enviromental auditing within the framework of sustainable development

Nowadays, large-scale agricultural overexploitation has left a very questionable balance of sectoral growth in Latin American economies due to the degradation of environmental conditions derived from the intensive use of a non-renewable energy base, pollution and the water footprint on ecosystems, the increase in carbon emissions, and climate change. These questions occur within the framework of alternative theories of development that are constructed as a holistic vision of the human being from a multidimensional perspective that challenges the theoretical-conceptual boundaries and the unidisciplinary logic of traditional science; so, ecodevelopment aims to reconcile the relation between man and the environment. This approach proposes an interpretative form of development for environmental sustainability (Hidalgo, 1998). Therefore, alternative theories seek to overcome the classic dogmatisms of modernization, structuralism, and even the developmentalist approach mediated by self-regulated markets that favor social convergence. Nevertheless, a large gap remains regarding implementing measures to achieve Sustainable Development Goals by countries and companies (Zhan & Santos-Paulino, 2021).

From this position, the economic sciences have rethought the discourse on sustainability and business development, as they promote automation processes in the role of organizations within society, which involve a systematic review of procedures and their modus operandi, over and above the traditional vision of microeconomic rationalism on growth and welfare (Castro, 2015). This pathway interprets sustainable development as comprehensively improving human living conditions in harmony with the

natural environment (Ioris, 2021). According to the Economic Commission for Latin America and the Caribbean (ECLAC, 2013), improvement in income distribution can hardly be achieved without high and sustained economic growth over time and a structural change in the current development model. Nevertheless, growth is not a sufficient condition, and the sustainability of development is economic and includes social and environmental sustainability (Bali-Swan & Yang-Wallenting, 2020).

The Brundtland Commission proposed development according to some pillars that must be balanced: (1) population and human resources, (2) food, (3) species and ecosystems, and (4) energy use, as fundamental criteria to ensure the satisfaction of future needs and intergenerational living conditions (UN, 1987; Tabas, 2021). Meanwhile, at the Rio de Janeiro Summit (UN, 1992) and the Johannesburg Political Declaration (UN, 2002), the need to promote economic and social development was made evident, but with a focus on local, national, regional, and global environmental protection.

This recommendation has been protocolized in various international treaties and, above all, in a wide range of interdisciplinary research that has served as a comparative baseline for understanding sustainability issues. These fields have created a new sociology of current production patterns and the future of the earth, which have recently become the moral duty of governments, institutions, and academic communities, leading to the creation of new disciplines and the involvement of different communities and economic and political interest groups (Timpson et al., 2006). Therefore, sustainability, defined as the balance that exists between the use of available resources for the satisfaction of social needs and the conservation of life in its different forms (Confetto & Covucci, 2021; Suárez & Vázquez, 2014), requires a social pact and an ethical and moral commitment of organizations, which translates into what has been called Corporate Social Responsibility (CSR) (Visser et al., 2010).

Accordingly, CSR has led to a series of regulations (Herrera & Mayka, 2020), especially environmental certifications, to promote clean production processes, environmental management, recycling, the implementation of renewable energies, the reduction of emissions, and all measures that favor the environment. Therefore, sustainability initiatives are usually processes promoted by transnational organizations interested in fostering production with a sustainable approach, institutionalizing the recognition of such efforts in production from the areas of resources, human management, social responsibility, corporate values, environmental care, and other terms that simplify the relation "company-man-natural environment." Thus, environmental auditing verifies compliance with these sustainability requirements (Godínez et al., 2010; Lu et al., 2020; Vargas et al., 2011).

Traditional auditing has been used in organizations to evaluate, anticipate, and control the financial situation of companies (Knechel et al., 2020). Nevertheless, in light of the need to preserve the environment, initiatives have been created that entail the development of environmental audits, which are recognized through international certifications such as the ISO 14001 Standard and, at the agricultural

sector level, those of Fair Trade (FLO), Organic Coffees (IFOAM), Rainforest Alliance, and UTZ Certified (Ramírez & Andrade, 2017).

Environmental auditing is a system that enables objective and preventive verification and evaluation to contribute to organizations' decision-making. Luna (2012), Mantilla (2015), Shrivastava (2003), and Marwa et al. (2020) agree that environmental auditing is designed to account for environmental problems that develop in companies, which can be counteracted through process verification and evaluation. Productive organizations that embrace sustainability principles must have a whole operational scaffolding and implement actions and methods in their processes that break paradigms and functional operation patterns (Castka et al., 2020). These morphological transformations of the organization are usually recognized precisely through systems of certification and verification of sustainable processes in environmental auditing (Sanjana & Venkatesam, 2020).

Audit of sustainable processes in coffee production

In rural coffee organizations, environmental auditing has been institutionalized through the specialty coffee production approach to improve sectoral competitiveness and farmers' quality of life and promote environmental care (Navarro *et al.*, 2020). These result from business inducements promoted with price premium incentives or as altruistic measures by the producers to harmonize agricultural activity with ecosystem care (Andrade & Gracia, 2018). For this work, two groups that comprehensively use sustainability approaches in the production process were identified. One of these is recognized by implementing and complying with standards with regulations or private policies that bring together large industries dedicated to manufacturing coffee, such as Starbucks and Nestlé. Their main objective is implementing productive procedures, assuming quality standards such as the Common Code for the Coffee Community (4C), the Nespresso AAA verification, or the C.A.F.E. Practices code (Giovannucci & Ponte, 2005). The other group is led by international organizations that promote quality processes based on sustainability ethics, such as Organic Coffee, Fair Trade International (FLO), UTZ Kapeh, and Rainforest Alliance (Giovannucci *et al.*, 2008). The main characteristic of these processes, relative to those that establish codes of conduct, is the issuance of certificates or quality seals awarded through continuous monitoring of compliance with environmental, economic, and social parameters (Ningsih *et al.*, 2020).

There is a marked difference between the two groups of specialty coffees. In the first case, production standards are governed by the corporate policies of the manufacturing companies that review compliance with codes of conduct, in which case the reprimands are not strictly monetary but rather related

to improving processes. On the contrary, the implementation of quality seals has a continuous control, which is determined by the renewal of certifications, and, accordingly, non-compliance dictates sanctions that can even cause the loss of the quality seal. It is estimated that the first group is a kind of incubator of good praxis that producers tend to capitalize on through the implementation of certifications in the second group.

Parallel to the two previous classifications, some proposals from coffee producer organizations follow quality guidelines and have regional recognition, for which they occasionally receive premium prices similar to those of specialty coffees. These associations pursue particular benefits that endorse their production processes, such as those identified in certified coffee, so it is estimated that it can also be a preliminary step to join this system (CRECE, 2008). Organizations with economic and social power usually represent these proposals and aim to improve their sales prices over conventional coffee.

The certification endorsed by the Fair-Trade Labeling Organization (FLO) mainly aims to improve the characteristics associated with welfare, income and production conditions for the associations and production units. The particular characteristics of this seal include, in addition to making the required controls for compliance with the standards in production processes, providing evidence of compliance statistics that materialize in sales premiums for farmers. More than 17 organizations are operating in various parts of the world according to the parameters of FLO, including those that produce cocoa, sugar, bananas, honey, and fruit substrates. The audited activities generally involve production organization, the treatment of workers in terms of health, welfare, and occupational safety, and environmental protection under environmental and social standards. These verifications are performed annually, and the producer groups usually share the certification costs.

Organic coffee that is certified according to the standards of the International Foundation for Organic Agriculture (INFOAM) is verified through the use of production methods without the use of synthetic agrochemicals (fertilizers and pesticides), and the entire production chain is inspected from the cultivation techniques to threshing, storage, and transportation. The organization seeks to guarantee the proper use of soils and product quality, promoting fertilization and pest and disease management through organic inputs that favor the conservation of biodiversity, biological cycles, and the biotic functioning of the environment. This certification audits the conservation, protection, and improvement of the soil, the proper use of organic fertilizers and fungicides, the regulation of monoculture plantings, and the monitoring of administrative, productive, and commercial processes by coffee growers. For this type of specialty coffee, there is a strong demand and sales prices above those of conventional coffees and even those of other certified brands.

Meanwhile, Rainforest Alliance Certified is recognized as a quality system based on the harmonious relation between production and the environment according to the parameters of the

Sustainable Agriculture Network (SAN) (Dietz *et al.*, 2020). The audit conditions are based on verifying social and environmental management systems, ecosystem and wildlife conservation, water resources, and integrated crop, soil, and waste management. In social matters, good treatment of workers, occupational health and safety conditions, and relations with the community are verified. Their objectives are based on seeking a balance between supply and demand, making it possible to be competitive in market conditions. The certification also extends to other crops, such as tea, fruits, and flowers. The Rainforest Alliance can be implemented on large farms and coffee plantations. The certification criteria are essentially based on environmental standards, good human management policies, and community quality of life (Dietz et al., 2020; Sellare et al., 2020).

Finally, UTZ Certified from the UTZ Kapeh Foundation seeks to guarantee the implementation of good agricultural procedures and coffee quality management, permitting, in addition, the recognition and importance of the conservation of the environment and the quality of life of producers and workers. The seal verifies quality conditions in the product and production processes; criteria such as productivity and income received by producers, wages, financing conditions, and the quality of life and infrastructure of the farms are also considered. Labor rights, occupational safety, child labor, and school attendance are also monitored. In the environmental area, the quality and health of the soil, the efficient use of water and energy, the reduction of waste and pollution, and the protection of natural habitats are verified. UTZ's advantages include its recognition in the specialty coffee market, which provides guarantees in terms of sales price premiums. Potential beneficiaries of UTZ certification are large producer groups and coffee grower cooperatives. Table 1 shows the quality criteria audited for the Certifications or Quality Seals.

The quality panorama is similar in the case of initiatives for the verification of codes of conduct. Nevertheless, inspections are more flexible and aim to guarantee sustainability in production procedures under standards defined by international entities and clients to gain access to different markets and benefits in price premiums. Nespresso AAA, for example, has established in its policies the good management of quality standards in light of social, economic, and environmental aspects very similar to the Rainforest Alliance standards. These standards must be evaluated periodically, and compliance may occasionally limit commercial conditions. The parameters are focused on the chains of custody to commercialization and acceptance of small producers that fulfill the characteristic of having quality coffee. The program significantly benefits producers in terms of technical and social assistance (Sellare *et al.*, 2020).

Table 1
Criteria audited by quality certifications or seals of approval

Criteria	Fair Trade-FLO	ORGANIC	RAINFOREST ALLIANCE	UTZ CERTIFIED
Commercial conditions	Traceability, contracts, and trademarks	Traceability in transportation, warehousing, and packaging	Verification of the entire chain of custody beyond the production cycle.	Product quality verification ensures sales premiums.
Production	Compliance with the Internal Control System (ICS)	Follow-up of administrative, productive, and commercial processes according to the quality manual.	Compliance with Sustainable Agriculture Network (SAN) standards. Regulates distances and densities of ecosystems and housing units	Compliance with Good Agricultural Procedures and the administrative management of the farms is verified—likewise, productivity, income, financing conditions and infrastructure.
Environmental Development	Environmental management, pesticides and fertilizers, water use, soil management, waste, biodiversity, CO2 emissions	Fertilization and management of pests and diseases through the use of organic inputs, care of the environment, biodiversity conservation, and regulation of monoculture crops.	Verifies social and environmental management, ecosystem and wildlife conservation, water resources, integrated crop, soil, and waste management.	Verifies soil quality and health, efficient water and energy use, waste and pollution reduction, and protection of natural habitats
Working conditions	Rights, freedom of labor, child labor, associativity, and occupational safety.	Workers and their families can access clean water, food, housing, education, transportation, and health services.	Good treatment of workers and occupational health and safety conditions	Compliance with labor rights, occupational safety, child labor, and school attendance.
Organization	Participation and empowerment in the associations as it is specially oriented to producer groups	Not verified. Any individual producer can undergo verification for certification.	Not verified, although measures are suggested for good relations with neighbors and the community and the local interests of the producers.	Participation and empowerment in producer associations that participate in the certification initiative

Source: created by the authors

Meanwhile, Starbucks supports the C.A.F.E. Practices initiative based on social welfare and coffee quality. The codes of behavior are verified in the supply chain from the production, harvesting,

processing, and commercialization processes. Accordingly, it has fundamental criteria based on financial and social responsibility and environmental leadership. Compliance with product quality is verified through the "golden bean" criteria under European Preparation (EP) standards and cup quality; likewise, financial responsibility is verified through documentation and traceability of payments for the sale of coffee, remuneration to workers and credit conditions, among others. The social responsibility component is audited through compliance with best practices regarding hiring, wages, collective bargaining, child labor, occupational safety, and access to basic services. Finally, environmental leadership is evaluated through protecting water resources, soil, conservation of biological biodiversity, and environmental management. This dimension has very rigorous guidelines for using resources for coffee processing. For producers operating under the verification of C.A.F.E. Practices, almost all coffee has a price premium due to the good relations and market structure leveraged by the firm promoting this initiative.

On the other hand, the common code for the Coffee Community (4C), unlike Nespresso AAA and C.A.F.E. Practices, is a verification system that is not corporate, so the demand for coffee is not always assured, and sometimes only 10% of the coffee sold has a price premium. It is recognized as a global community that promotes the improvement of the economic, social, and environmental conditions of coffee producers through the fulfillment of 28 principles in the production, processing, and trading of coffee. It has a three-stage traffic light evaluation system with three dimensions audited. For example, freedom of association and bargaining, discrimination, child labor, wages, occupational health and safety, skills development, and living conditions and education are verified in the social area. The environmental dimension considers biodiversity conservation techniques, use of chemical products (pesticides), soil conservation, fertilization, water use, energy, and waste disposal. The economic area considers coffee quality, market access and information, records management, and the traceability system. This model seeks to stimulate good agricultural-administrative methods on coffee farms and is aimed at small producers and coffee growers' cooperatives. Table 2 shows the audited criteria based on compliance with the codes of conduct.

In general, sustainability certifications and initiatives operate according to membership parameters with entry and retention requirements subject to each auditing company's internal standards (Sellare *et al.*, 2020). Similarly, a continuous verification process is regularly conducted once a year and must be undertaken by the producers or, in the case of group certifications, by the coffee growers' associations and organizations with the quality seal. In all cases, the pillars that make up the sustainability criteria are economic, social, and environmental (Khokhar *et al.*, 2020).

Table 2
Criteria audited in the codes of conduct for sustainability initiatives

Criteria	Nespresso AAA	Café Practices	4C
Commercial conditions	Verification of the entire chain of custody	Compliance with product quality using golden bean criteria under European Preparation-EP standards and cup quality	Traceability, market access, and information procedures are verified.
Production	Partial compliance with Sustainable Agriculture Network (SAN) standards.	The process is verified through documentation and traceability of payments for coffee sales, workers' compensation, and credit conditions, among others.	Verification of coffee quality, records management, and farm management
Environmental development	Verifies social and environmental management, ecosystem and wildlife conservation, water resources, integrated crop, soil, and waste management.	Protection of water resources, soil conservation, biological biodiversity, and environmental management.	Biodiversity conservation procedures, use of chemicals (pesticides), soil conservation and fertilization, water and energy use, and waste disposal
Working conditions	Good hiring conditions, occupational health and safety, and employee benefits	Compliance with best practices regarding hiring, wages, collective bargaining, child labor, occupational safety, and access to basic services	Freedom of association and bargaining, discrimination, child labor, wages, occupational health and safety, skills development, and living conditions and education
Organization	Not verified. This initiative is aimed at small producers	Not evident	Not evident. It is aimed especially at small producers and coffee growers' cooperatives

Source: created by the authors

Materials and methods

The sustainability conditions in coffee farms that adopt quality standards or are certified in specialty coffees were analyzed through a comparative study in 23 production units in the department of Caldas, a traditional coffee production zone in Colombia. For this purpose, a counterfactual of 26 farms in the same zone that traditionally produce coffee was also taken. The distribution of the sample considered that the farms should have most of the area under coffee cultivation and a homogeneous structure in terms of size and production. The result of this exercise corresponds to the piloting of the project "Analysis of sustainable processes under quality standards in coffee production in Caldas," led by the Center for Research in Environment and Development of the University of Manizales.

The field instrument is composed of 72 questions structured in 8 modules, where questions were asked about (1) general aspects of the producer and the farm; (2) production and marketing structure; (3) social conditions in the production unit; (4) water resource management; (5) solid waste; (6) soil management; (7) biodiversity conservation; and (8) aspects of certification or implementation of quality standards. 34 indicators were obtained, grouped in technical, economic, social, and environmental sustainability dimensions, based on the main parameters audited by the companies certifying quality conditions and those verifying the codes of conduct described in Tables 1 and 2. Once the categories and evaluation variables were defined, a standardization exercise was carried out in five clusters using STATA's Cluster *(k)* application. This technique enables the dimensionality of the variables to be reduced according to their variance to achieve maximum homogeneity among different types of subgroups (De la Fuente, 2011). For this purpose, a series of transformations had to be generated in the categorical, nominal, and numerical variables to integrate the unit of measurement into an ordinal scale. Table 3 shows the details of each indicator.

Table 3
Sustainability indicators

Dimension	Indicator	Detail of information
Economic	Production costs	Producer's estimate per bushel
	Economic profitability	Revenues minus Costs per bushel
	Sales price perception	Producer rating (Likert scale)
	Commercial intermediation	Type of buyer to whom the coffee is sold
	Ease of commercialization	Time to bring coffee to the point of sale
	Income diversification	Tradable products other than coffee
	Number of forests and bamboo stands	Areas with forest coverage (Likert scale)
	Species diversity for shade	Number of species for coffee shade
	Wildlife diversity	Perception of the presence of wildlife species on the farm (Likert scale)
	Wildlife protection	Wildlife hunting (Likert scale)
	Erosion	Percentage of eroded area on the farm
	Soil cover	Percentage of soil cover on the farm
	Weed management	Coffee weed control techniques
	Solid waste management	Garbage disposal methods on the farm
	Wastewater management	Type of structure for the disposal of domestic and coffee processing wastewater.
	Water care	Presence of live fences on the farm
	Wetlands	Distance of crops from water bodies
	Carbon capture	Aerial biomass of coffee shade species

Social	Generational handover	Average age of coffee producer
	Housing conditions	Perception of the level of habitability of the dwelling on the farm (Likert scale)
	Fuel	Type of fuel used for cooking
	Safe water	Source of water supply for domestic consumption and coffee milling
	Water supply	Availability of water supply (Likert scale)
	Social security	Affiliation to the health and pension system by the producer
	Payment of salaries	Gap in the payment of wages at the farm and village level
	Degree of associativity	Participation in producer associations
Technical	Records management	Income and expenditure control
	Coffee age	Average age of coffee
	Coffee milling	Type of mill on the farm
	Production potential	Potential bushes in production (3 - 8 years) according to the total number of coffee bushes on the farm
	Seeding density	Number of plants/ha
	Crop diversification	Percentage of land uses for other crops
	Coffee quality	Percentage of poor-quality beans
	Production	Average production in the last 3 years (@/ ha)

Source: created by the authors

With the classification by clusters, the sustainability scales for each dimension were determined in a range of one to five so that values between 0 and 1 indicate a completely unsustainable state, between 1 and 2 a low sustainable state, between 2 and 3 somewhat sustainable, between 3 and 4 moderately sustainable, and between 4 and 5 a highly sustainable state. Subsequently, a Synthetic Sustainability Index (SSI) was estimated, grouping by dimensions the performance of each indicator in the four sub-dimensions studied. The formal expression of the indicator is defined as:

$$\overline{SSI}_j = \frac{\sum_{i=1}^{n}[\alpha T_i + \gamma E_i + \mu S_i + \pi A_i]}{j} \quad (1)$$

Where $\overline{SSI}$ is the weighted average of each vector from the coefficients α, γ, μ and π that have an equivalent relative weight for each dimension defined in an ad-hoc manner. Meanwhile i represents each production unit according to the index value, and j the number of dimensions that make up the Synthetic Sustainability Index, defined as the vectors T, E, S and A, respectively, according to the sustainability dimensions of the $\overline{SSI}$. The index values are distributed as follows $0 \leq \overline{SSI} \leq 5$. For the analysis of the samples, a Kruskal-Wallis asymptotic significance test was used to determine the distribution structure of the samples from certified farms or farms that follow codes of conduct and farms producing conventional coffee. The results indicate a similar distribution between both groups; therefore, it was possible to make comparisons of means for each value of the synthetic index and in each

subdimension. Finally, the results were plotted in an Amoeba Matrix to determine each indicator's behavior between the specialty and conventional coffee growers.

Sustainability audit of coffe farms in Caldas

The department of Caldas's coffee-growing area contributes around 10% of Colombia's coffee production, and it is estimated that it has around 35 thousand farmers dedicated to this activity (Castro, 2014). More than 23% of coffee farms in the country produce specialty coffees; in Caldas, the figure is estimated to be close to 30%. In the case of the municipalities where the study was focused, there is also an important dynamic of insertion in the production of specialty coffees, particularly in the implementation of codes of behavior thanks to the promotion of this type of program by the coffee associations and the producers' associations. The organizations that predominate in the area analyzed are Nespresso AAA, Rainforest, and FLO; nevertheless, it is recognized that in the eastern sub-region of Caldas, there is also a significant presence of the Starbucks verification program (C.A.F.E. practices). In general, the type of farms studied correspond to smallholdings of around 3 hectares with an important dependence on coffee, which is consistent with the general structure of the department, where 63% of the farmers are smallholders (Comité Departamental de Cafeteros de Caldas, n.a.). The main characteristics of the farms analyzed are summarized below (Table 4).

Table 4
General characteristics of producers and farms

Municipality	Specialty Coffees		Conventional Coffee	Total farms	% Men	Producer years	Farm size (ha)	% Coffee
	Certification	Code of Behavior						
Aguadas	2	7	5	14	57	48.5	2.5	66
La Merced	1		8	9	89	46	1.7	77
Marmato		1		1	100	35	2.5	63
Pacora	2	7	1	10	100	46.2	5.2	79
Samaná	2	1	12	15	93	50.9	2.6	50
Total	7	16	26	49	84	48.1	2.9	66

Source: created by the authors

Most coffee growing units implement monoculture systems (96% of the farms) that add up to a coffee dependency rate of more than 65%. Although a proportion of the area is also destined for other permanent and transitory crops such as avocado, banana, citrus, fruit trees, and other uses, the dependency and income diversification indices are critical. These aspects are key as a parameter of economic

sustainability on the farms. Nevertheless, it is one of the main shortcomings in both production models, which it has been sought to address through technical assistance services promoted by the coffee institutions and the certifying companies or those that adopt verification systems. To this end, more than one-third of the producers receive assistance in terms of crop technification, agricultural and cultural methods, and coffee quality, with which, in the production units of specialty coffees that undergo periodic auditing processes, the results are more efficient in terms of planting densities, coffee variety, productivity, and the management of the farms. In any case, the many difficulties have prevented better results due to the transitional nature of implementing codes of conduct, such as coffee processing techniques, crop renewal, and diversification of income sources.

The audit parameters regarding technical sustainability focus mainly on record keeping, coffee quality, and safety and traceability conditions. In this regard, it was identified that the proportion of specialty coffee producers who practice administrative measures, such as cost accounting, production volumes, invoices, and sales records, is much higher than that of conventional coffee producers (60% and 45%, respectively). According to the producers, this is due to the technical assistance service's support and the frequent auditing process monitoring. Likewise, specialty coffee producers have better coffee processing techniques, although, in the case of the sample, this was not reflected in the quality of the coffee. Furthermore, this parameter focused mainly on the number of by-products resulting from the milling process (pasilla) rather than on the safety conditions, the performance factor or the tasting test. The performance of the technical sub-dimension for producers of conventional and specialty coffees is summarized below (Figure 1).

In addition, the economic performance of the farms, as an audit criterion, is based essentially on profitability and marketing conditions. These parameters turned out to be more sustainable in specialty coffee farms since the higher sales prices and the efficiency in productivity allow for higher profit margins and better marketing guarantees added to the advantage of the benefits of association in this type of production system. In this regard, it was identified that a specialty coffee producer has production costs of around USD 18.4 per bushel and sells the coffee at USD 29.2 per bushel, in addition to profit margins of more than 30% above those of a conventional coffee producer. Likewise, the economic intermediation margin is lower, and their coffee has better marketing conditions.

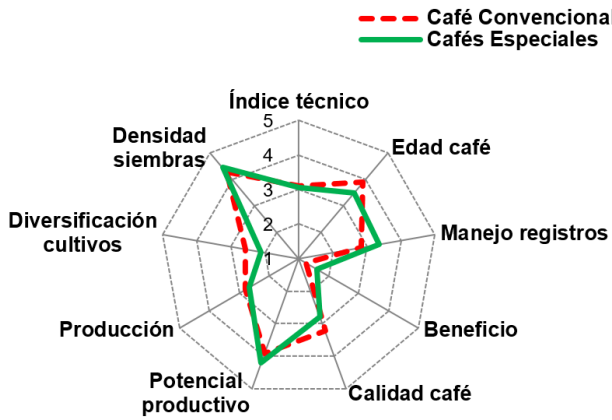

Figure 1. Results of the sustainability index in the technical subdimension
Source: created by the authors

Accordingly, producers that undergo these auditing processes through sustainable systems are expected to be more satisfied with the sales price and the guarantees they obtain in the coffee business, as demonstrated in the study's results. In any case, a critical aspect in both production models has been the possibility of generating additional income to guarantee the economic sustainability of families in unproductive seasons. This scenario explains why more than 70% of the farms depend exclusively on coffee and some cash crops. The situation seems to be more critical in farms producing specialty coffees. The following is an overview of the index in the economic subdimension for both types of producers.

In terms of social criteria, auditing systems regularly weigh up, in particular, the living conditions of producers and the labor relations with workers. Similarly, parameters such as the linkage to the social protection system, child labor, education, and social organization in coffee growers' environments are also audited. Accordingly, the social sustainability index was much higher on specialty coffee farms, especially regarding associativity, trade union ties, and the living environment. In any case, the index weights indicate that, in social matters, both types of production models have a moderately sustainable level compared to the objective evaluation parameter. This result is explained by the general precariousness of rural areas in terms of income generation and coverage by the social protection system. In this regard, it is estimated that, on average, a coffee family in the group of farms analyzed has a profit margin of a little less than USD 400 per month to cover their basic expenditures and reinvest in the business.

Moreover, only 10% indicate that they are affiliated with the pension system, and although almost all of them have health coverage, it is part of the state-subsidized system. Nevertheless, on the

farms studied, child labor was found to be less than 20% and under conditions of parental supervision. In addition, where minors were found, the school attendance rate was 92%.

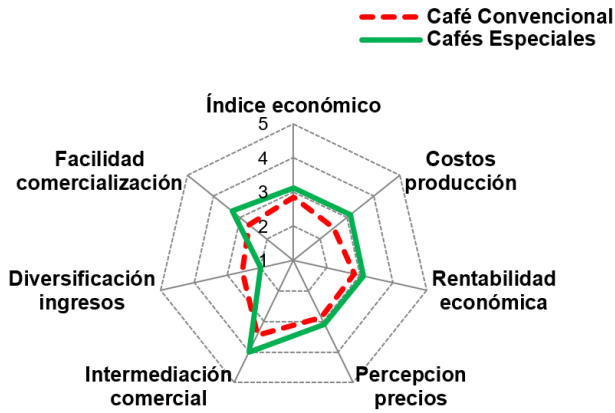

Figure 2. Results of the sustainability index in the economic subdimension
Source: created by the authors

The workers' remuneration conditions in both production systems were higher than those of the farms in the immediate geographic environment; nonetheless, wages are lower than the average in other areas of the country. The results show that the average daily wage on a specialty coffee farm is USD 12.1, and on a conventional coffee farm, USD 11.7 per day. Nevertheless, this academic exercise did not consider unpaid family work, a critical issue in coffee auditing criteria.

Finally, the level of guild empowerment suggests that specialty coffee producers maintain themselves in an atmosphere of improved social relations that, in part, are determined by the adoption of quality standards and codes of conduct. The social index shows a noticeable difference in the degree of associativity between producers of specialty and conventional coffees, which is explained by the fact that more than 95% of the coffee growers that are certified or follow codes of conduct are members of a producer group and 96% participate in grassroots community organizations. Promoting coffee institutions in the region stands out in this aspect, given that the associativity index of conventional coffee producers is also high (64%). From an auditing perspective, companies promoting certification processes are more insistent than corporate verification bodies in fostering the participation and empowerment of producers in associations that promote quality initiatives. As a result, certifications are often granted collectively to groups of producers who jointly take on these challenges and adapt to a culture of self-regulation and solidarity. Figure 3 shows the performance of the social index for the two production models.

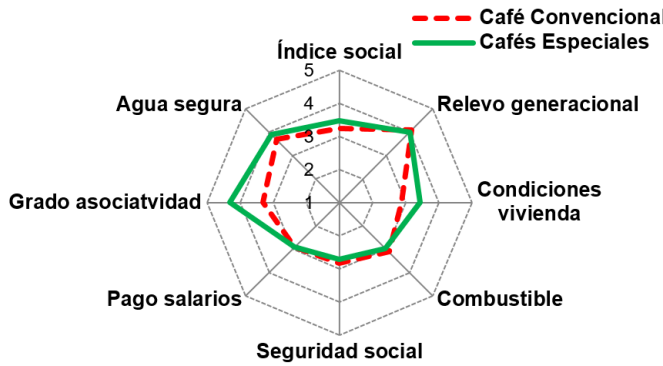

Figure 3. Sustainability index results in the social subdimension
Source: created by the authors

It is in the environmental aspects where more auditing standards are observed precisely because of the conservationist nature of most of the certification bodies. The most significant criteria focus on evaluating integrated crop management, managing resources such as water sources, energy, and soil, biodiversity conservation and pollution reduction, and environmental services. There were no conclusive results in this factor that would permit the attribution of a better performance of specialty coffee farms in the subregions analyzed, except for some criteria such as solid waste management, protection of fauna, diversity of shade species, and care of water courses. It should be noted that there is a significant water supply in the territorial environments where the farms analyzed are located, so the water available for human consumption and coffee processing is of good quality.

In any case, in the coffee sector the most important challenge in environmental terms continues to be water management since bad practices persist, such as the logging and expansion of the agricultural frontier in buffer zones of water bodies and the indiscriminate use of water for coffee processing, which results in higher rates of wastewater contamination. It can be seen that only 20% of the farms have ecological processing systems, and few have adequate wastewater treatment systems. Despite this, it is important to recognize the progress in environmental awareness measures that the technical assistance services have achieved, since currently more than 70% of the producers indicate that they implement measures to manage and care for water on the farm, such as reforestation and the installation of septic tanks.

On the issue of soil management, there are companies such as Organic Coffee that concentrate their efforts on reducing synthetic inputs for fertilization and pest management. Nevertheless, most other certifications or sustainability initiatives focus particularly on controlling and handling agrochemicals.

Over a third of coffee growers on the farms studied produce organic fertilizers from by-products such as coffee pulp, organic matter, and animal manure. Nonetheless, the use of these fertilizers for coffee fertilization is relatively low since 93% of the producers continue to fertilize with mineral products. Likewise, weed management and soil vegetation cover do not present favorable levels of sustainability since the intensity of the monoculture system and the reduced protection with shade trees tend to increase the level of exposure of soils to sunlight, which intensifies vulnerability to erosion (the level of erosion on the farms is 9%). In addition, weed management techniques have been mechanized, and chemical spraying has been increasing. To this end, environmental responsibility criteria seek to improve monitoring in this area without significantly affecting economic profitability and productivity through incentive systems in sales bonuses and social recognition of this type of initiative by awarding quality seals.

Likewise, wildlife conservation and biodiversity are relevant criteria for environmental auditing, especially for companies such as Rainforest Alliance and other lesser-known regimes in Colombia, such as Bridfriendly. Notwithstanding, in the region, certification organizations and verification of codes of conduct have a more social and economic focus, so the biodiversity characteristics do not have better results, except in measures for the prevention of hunting of wild animals, an aspect that is important for specialty and conventional coffee farms, and which is also associated with the current regulations for the carrying of firearms. Figure 4 shows the general results of the environmental sustainability index.

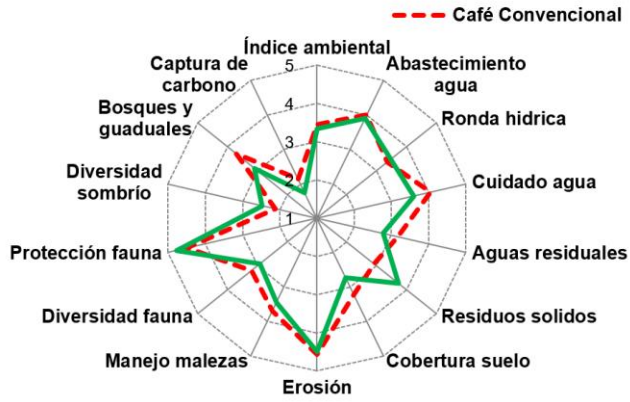

Figure 4. Sustainability index results in the environmental subdimension
Source: created by the authors

The biodiversity rating for the coffee region analyzed is moderately sustainable from the point of view of the environmental index. Nevertheless, it must be recognized that it is affected by the intensity of monoculture and the scarce coverage of shade trees in the area. In 96% of the farms, the average monoculture coffee cultivation is 50% of the cultivated areas, considering that the main system of association is the production of banana and avocado and there is a low number of shade trees in the middle of the coffee plantations (on average 17 trees per hectare). In addition, the number of shade species is only 3.7 species per hectare (3.4 for conventional coffee and 4.1 for specialty coffee), where Guamo (Inga edulis Mart) and Walnut (Cordia alliodora) predominate. These characteristics imply that the potential for carbon capture to mitigate CO_2 emissions is much lower than in other regions of the country. Indeed, in the studied areas of Caldas, it is estimated that coffee shade trees can capture approximately 6.3 tons of carbon per hectare per year. In contrast, farms in the department of Santander in Colombia, where agroforestry systems are cultivated in association with coffee, have the potential for CO_2 capture at 56.1 tons per hectare. This situation is also explained by the greater coverage and diversity of species (6 species per hectare) and the greater number of shade trees cultivated with coffee in Santander, which sometimes reaches up to 152 trees per hectare.

In general terms, for the environmental dimension, although it is a major commitment of the organizations that carry out auditing processes for the certification of quality or the verification of compliance with the coffee codes of conduct, in the region studied no convincing results were observed for specialty coffees compared to the production of conventional coffee. However, these differences were not statistically significant in the equality of variances test. In any case, the result in this dimension is explained by the fact that the majority of specialty coffee-producing farms in the area of analysis are mainly focused on social and economic sustainability initiatives that do not have strictly environmental purposes, as is the case with certifications and quality seals such as Rainforest Alliance and Organic Coffee.

These facts are similar for the economic and social dimensions, for which, although they have comparatively higher values in specialty coffee farms compared to conventional production, the differences are not statistically significant; nevertheless, at the general level of the SSI, there is statistical significance in the results, even though both production models can be classified as moderately sustainable. In this perspective, it can be concluded that the submission to auditing processes for the management of sustainability in coffee farms producing specialty coffees has had marginally better results than the farms that conventionally produce coffee and, therefore, an atmosphere of good practices has been institutionalized that makes this an efficient model with better economic returns. Table 5 shows the overall results of the index by sustainability dimensions.

Table 5
Synthetic Sustainability Index

Result	Conventional Coffee	Specialty Coffee	F	Sig.
Synthetic Index (SSI)	3.161	3.246	3.722	0.06**
Technical Index (T)	3.093	3.061	1.454	0.234
Economic Index (E)	2.847	3.104	1.008	0.321
Social Index (S)	3.248	3.473	0.018	0.894
Environmental Index (A)	3.457	3.348	0.171	0.681

Statistical significance: *** p<0.01, ** p<0.05, * p<0.1

Source: created by the authors

The coffee institutions have in part been the promoters of these good auditing procedures, as indicated by more than 74% of the producers interviewed. In addition, there is an atmosphere of empowerment, a high level of acceptance by the coffee growers who participate in this type of program, and a prospect of continuity in the medium term of more than 95%. The most aspects that coffee growers consider having had the greatest impact since they have been producing specialty coffees under quality standards have been the conditions of productivity and quality of coffee, the conservation of natural areas, the care of water bodies and the technification of crops. For this purpose, it has been necessary to make technical adjustments such as the renovation of coffee plantations and the implementation of better structures for the milling and the administrative management of the farm, among others. Nevertheless, the results of these processes in the years that good production processes have been implemented (an average of 4.3 years) are perceived as efficient, and most producers are satisfied.

Discussion

The situation identified in the farms, with quality standards subject to environmental auditing processes, reveals the gaps between conventional production systems and the new technification and regulation of agricultural units governed by ecological and socially responsible principles. Nevertheless, they also present economic and technical challenges to ensure their sustainability, especially when a balance must be struck between economic profitability and conservation objectives. Considering that coffee growing in Colombia is carried out in small production units, although favorable in environmental terms, it is at the same time disadvantageous in economic and social terms, due to the limited investment capacity and inefficient cost management of small-scale production, because of the limited technical operation of subsistence production units.

This result is consistent with the conclusions of Valkila (2009) on coffee producers in Nicaragua if it is considered that low-intensity production models marginalize farmers to conditions of poverty and, often, the economic advantages of specialty coffee production depend to a large extent on market prices and the global economic situation. In addition, returns from the business do not necessarily ensure sufficient capitalization income and coverage by social protection and social security regimes.

This fact makes it necessary to reduce dependence on coffee and diversify income in other permanent crops, especially considering that one of the parameters proposed by Rojo and Pérez (2014) to think of truly sustainable coffee growing is the expansion of income sources and good commercial and price conditions. This fact also calls into question the technical efficiency, the parameters of high productivity, the model of productive specialization in monocultures, and the coffee business's true profitability.

In this perspective, although the quality standards are favorable for the good environmental and social performance of the coffee farms, commercial conditions and the quality of the coffee are often not impacted by the submission to environmental audits since this depends on the focus of the certifications and the claims of the producer.

Similarly, the submission of certified farms to auditing systems, although improving technical efficiency and administrative management, is not always reflected in socio-environmental terms, given the large investments that producers must make, making the coffee business less profitable. Castro et al. (2017) posit that occasionally certifications on agricultural farms are not adjusted to environmental needs, mainly because of the lack of alignment between regulations and agriculture according to the technical and legal parameters desired from environmental management. Therefore, it is recognized that environmental certification models, more than a political commitment, should be an ethical conviction of entrepreneurs to obtain better results, not only economically but also socially and environmentally.

As stated by Patriarca et al. (2017), sometimes environmental audits do not have an impact on improving the environmental performance of organizations because they do not generate improvement plans or because these, in some cases, are more influenced by external conditions motivated by competitiveness in the market, than by a real altruistic view of the producer. Prajogo et al. (2016) indicate that many companies that persist in implementing ISO 14001 certification do so more for internal conditions of the organizational culture for environmental care and social responsibility than for purposes of social recognition to gain space in the market. Even companies that operate according to that mercantile logic tend to enter more easily into the parameters of ISO 14001 certification.

As stated by Cavero-Rubio and Amorós-Martínez (2017), companies in the agricultural sector certified with environmental auditing processes have better financial performance because environmental auditing processes are a resource that creates competitive advantages. In addition, specialty coffee farms

that undergo periodic auditing processes have better results in terms of technical efficiency in seeding densities, coffee variety, productivity, and administrative management, a fact that is consistent with that identified by Altieri and Nicholls (2002) when they suggest that the measurement of sustainability standards positively influences coffee growers to apply ecological strategies that mitigate the environmental impact of their farms. At the same time, they improve productivity since using sustainability indicators helps each farmer visualize their performance and the state of their operation compared to a pre-established threshold. Such evidence has also been found in other studies on dark tobacco production in Colombia (Forero et al., 2018). In addition, as was found in this research, when the measurement methodology is applied in several farms, it is very useful for farmers because they can understand comparatively the reasons why they have a higher ecological response than others and what measures to implement to improve their methods with lower indicators (Merma & Julca, 2012).

On the other hand, from a social point of view, specialty coffee producers that undergo environmental audits maintain an atmosphere of better social relations, determined partly by adopting quality standards and codes of behavior (Serna et al., 2015). Indeed, Delmotte et al. suggest that participation and the evaluation of narratives developed locally in communities are vital to confronting the challenges farmers face with the political reforms of the international markets. In the case of the farms analyzed, it is highlighted that the coffee associations have promoted the coffee sustainability initiatives to improve the sector's competitiveness and environmental protection. This case is also seen in other sectors, such as sugarcane production in the department of Cundinamarca in Colombia, in which the capacity for social collaboration between different producers generates a benefit for the entire community derived from three elements related to affection, mutual trust, and agreed and collectively accepted rules, favoring the development of networks that allow technology transfer and scientific research in Colombian rural production systems (Forero & Ramírez, 2018)

In environmental matters, the most important challenge for the coffee sector continues to be water management, as bad management practices persist, such as logging and expanding the agricultural frontier in buffer zones of water bodies. This situation is evident in most coffee-growing units implementing monoculture systems. As has been proven in other international contexts, the main ecological problems of agricultural plantations are slash-and-burn and forest fires, deforestation, and prolonged droughts, which are related to low sustainability indices (Merma & Julca, 2012). It is well known that deforestation is among the main problems associated with coffee production due to extensive production in forested areas (Rojo & Pérez, 2014).

Regarding soil management, it is common for certifications to focus especially on controlling and handling agrochemicals, fertilization processes, weed management, and mulching. Nevertheless, the study results for the farms that produce with these parameters are not very different from those without

auditing processes if it is considered that most of them continue to fertilize with mineral products and that weed management and soil vegetation cover show unfavorable levels of sustainability. These results show that the intensity of the monoculture system and the reduced protection with shade trees tend to increase exposure to sunlight and erosion. These conditions coincide with the harmful effects identified by Rojo and Pérez (2014) on coffee growing due to the intensive use of chemicals, pesticides, and herbicides, and soil degradation depending on the method of cultivation, the percentage of soil organic matter, and the loss of nitrogen, potassium, and calcium that coffee demands for production.

Although most certification organizations have a primarily environmental focus, some farms have neglected biodiversity to increase economic profitability due to the intensity of monoculture and the low coverage of shade trees. This is partly because environmental audits often have no impact on the improvement of organizations' environmental activities. After all, they do not devise convincing improvement plans (Patriarca et al., 2017).

In any case, the environmental results are positive though marginal compared to the farms that do not undergo auditing. According to Díaz-Porras and Avendaño-Escudero (2014), the reason lies in the different agricultural balances that determine environmental impacts discretionally as an important source of the problem, according to the main impacts mentioned by Rojo and Pérez (2014). Nevertheless, these farms have made progress in promoting the care of ecosystems and the mitigation of environmental impacts, especially in the prevention of wildlife hunting, carbon capture, and conservation of natural areas and water bodies —likewise, the increased presence of shade trees within agroforestry arrangements that are key ecological conservation corridors. According to Primdahl et al. (2010), agri-environmental systems are more efficient and effective models for harmonizing the economic and conservation interests of production units. Hence, Milder et al. (2015) insist that sustainability standards will always be a factor that enables the conservation of biodiversity, regardless of the potential repercussions of the teleological purpose of the audit.

From the above overview, in general terms, there are wide-ranging challenges to improve environmental care and protection through auditing, which should be a commitment directly faced by the coffee sector and, in general, by all crop sectors. As Carey (2019) proposed, the agricultural sector must embrace implementing environmental auditing methods for sustainable development within the framework of new agricultural policies, the challenge of competitiveness, and sectoral regulations at the global level. It should be noted that agricultural companies certified from an environmental perspective usually perform better.

For this reason, measurements of sustainability standards should be promoted as they positively influence coffee growers to apply ecological strategies that mitigate the environmental impact of their farms and generate awareness of their responsibility as productive organizations (Cavero-Rubio &

Amorós-Martínez, 2017). Altieri and Nicholls (2002) proposed that agroecological responsibilities must be assumed by any farm, regardless of its administrative, economic, cultural, and geographic differences. This responsibility means that fulfilling a group of standards in coffee farms responds to their alignment with sustainable development, not as a purpose of corporate will but as a regulatory statute of governments.

Such initiatives will help to forge a better understanding of local agri-environmental priorities and potentially increase awareness of the critical role of farmers in environmental management (Purvis et al., 2009). Furthermore, according to Milder et al. (2015), such implementation of quality standards influences the good use of soils in critical biodiversity zones, mitigates deforestation and agricultural intensification, and also facilitates conservation measures as a way to compensate for the opportunity costs of protecting natural areas in vulnerable strategic ecosystems.

Conclusions

After interpreting the environmental audit from the point of view of certifications and sustainability initiatives in coffee production in Caldas, it can be seen that these are intended to be mechanisms to mitigate the impact of production on natural resources and, in general, favor the competitiveness of the sector under principles of economic and social sustainability in harmony with the exploitation of ecosystems. To this end, auditing is materialized not only in verifying procedures but also in the institutionalization of efforts to recognize the organizational intentions that transform the modus operandi of production units in the light of the relation "company-man-natural environment."

Although it is recognized that there has been progress in the modernization and technification of the field and the improvement in the living conditions of producers, there are questions regarding some of the processes in the way certifiers operate, especially because in not all cases are sales price premiums guaranteed. Private interests may promote the universalization of specialty coffees to cover market quotas. Nevertheless, it is important to recognize the progress made in world coffee growing since methods have been changing and, at present, quality standards have been well received, leaving an important balance of farms committed to the sustainability of the sector. This is a paradigm shift where the economic factor is equal to the social challenges and the care of ecosystems.

Likewise, environmental auditing has been a determining factor in contributing to the continuous improvement of production processes, which can be reflected in the sustainability of coffee-growing communities, according to some previous studies promoted by the National Federation of Coffee Growers of Colombia with the support of The Committee on Sustainability Assessment (COSA) in which several impacts on the pillars of development are shown in comparison to conventional coffees. In this

process, the models of verification, evaluation, and control applied in the rural zone to guarantee the quality of the productive processes of coffee growers should count on the efforts and accompaniment of the coffee institutional framework and different unions, committees, and cooperatives to formalize auditing and self-regulation as a strategy for the development of the coffee sector.

To this end, sustainability auditing can be a reflection of market intentions institutionalized in compliance with quality standards that, on the one hand, give signals to consumers of products that are manufactured under organized and sustainable production guidelines and, on the other hand, of consumption trends that intensify the need to technify production practices in the face of conflicts and the environmental crisis. For this reason, its effectiveness will depend on the efficiency with which information skewness between producers and clients is reduced, and the criterion of innovation that sustainable production brings to the development of humanity is universalized in the collective conscience.

Finally, the conceptualization of sustainable development establishes the pillars that must be balanced: (1) population and human resources, (2) food, (3) species and ecosystems, and (4) energy use (WECD, 1987; Strange & Bayley, 2008). Meanwhile, at the Rio de Janeiro Summit (UN, 1992) and the Johannesburg Political Declaration (UN, 2002), the need to promote economic and social development was evident, emphasizing local, national, regional, and global environmental protection. This represents the continuity of the reconciliation approach that the United Nations intends when referring to sustainable development. For this reason, definitions of sustainable development consistently encompass the integration and balancing of economic, social, and ecological concerns.

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