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Assessing the sustainability of Arabica coffee-growing householders in the Montanhas do Espírito Santo' geographic indication region, Brazil: an integrated case study

Avaliação da sustentabilidade em famílias produtoras de café arábica na região da indicação geográfica Cafés Montanhas do Espírito Santo, Brasil: um estudo integrado de caso

Evaluación de la sostenibilidad de las familias productoras de café Arábigo en la región de la indicación geográfica Café Montanhas do Espírito Santo, Brasil: un estudio integrado de caso

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Abstract
Coffee growing is an important activity for the income of farms and the production of specialty coffees should be encouraged. However, it is necessary that this process respects the principles based on the economic, environmental, and social axes of sustainability. This research was carried out in the municipality of Conceição do Castelo, State of Espírito Santo, Brazil aiming to assess the initial benchmark of the sustainability of three farms. The results showed a gap in the three axes with intervention needs mainly related to economic standards, followed by social and environmental. Different interventions and adaptations need to be used on each farm aiming to reach better levels of adequacy according to sustainability criteria; however, the values of the families and their limitations must be respected, particularly the economic, social, and cultural conditions. The three coffee farms need adjustments for the production of specialty coffees, mainly related to economic criteria. In this way, farms will be able to reach new markets, add value to coffee beans, increase farm income and develop sustainability.
Keywords: *Coffea arabica*; Economic, social and environmental criteria; Intervention actions; Specialty coffee; Sustainability evaluation.

Resumo
A cafeicultura é uma atividade importante para a renda das fazendas e a produção de cafés especiais deve ser incentivada. No entanto, é necessário que esse processo respeite os princípios baseados nos eixos econômico, ambiental e social da sustentabilidade. Esta pesquisa foi realizada no município de Conceição do Castelo, Estado do Espírito Santo, Brasil com o objetivo de avaliar o referencial inicial de sustentabilidade de três fazendas. Os resultados mostraram uma lacuna nos três eixos com necessidades de intervenção relacionadas principalmente aos padrões econômicos, seguidos pelos sociais e ambientais. Diferentes intervenções e adaptações precisam ser utilizadas em cada propriedade visando alcançar melhores níveis de adequação de acordo com critérios de sustentabilidade; entretanto, devem ser respeitados os valores das famílias e suas limitações, principalmente as condições econômicas, sociais e culturais. As três fazendas de café precisam de ajustes para a produção de cafés especiais, principalmente relacionados a critérios econômicos. Dessa forma, as fazendas poderão alcançar novos mercados, agregar valor aos grãos de café, aumentar a renda agrícola e desenvolver a sustentabilidade.
Palavras-chave: Ações de intervenção; Avaliação da sustentabilidade; Café especial; *Coffea arabica*; Critérios econômicos, sociais e ambientais.

Resumen
La caficultura es una actividad importante para los ingresos de las fincas y se debe fomentar la producción de cafés especiales. Sin embargo, es necesario que este proceso respete los principios basados en los ejes económico, ambiental y social de la sustentabilidad. Esta investigación fue realizada en el municipio de Conceição do Castelo, Estado de Espírito Santo, Brasil, con el objetivo de evaluar el punto de referencia inicial de sostenibilidad de tres haciendas. Los resultados mostraron una brecha en los tres ejes con necesidades de intervención relacionadas principalmente con los estándares económicos, seguidos por los sociales y ambientales. Es necesario utilizar diferentes intervenciones y adaptaciones en cada propiedad para lograr mejores niveles de adecuación según criterios de sostenibilidad; sin embargo, se deben respetar los valores familiares y sus limitaciones, especialmente las condiciones económicas, sociales y culturales. Las tres fincas cafetaleras necesitan ajustes para la producción de cafés especiales, principalmente relacionados con criterios económicos. De esta manera, las fincas podrán llegar a nuevos mercados, agregar valor a los granos de café, aumentar los ingresos agrícolas y desarrollar la sostenibilidad.
Palabras clave: Acciones de intervención; Cafés especiales; *Coffea arabica*; Criterios económicos, sociales y ambientales; Evaluación de la sostenibilidad.

1. Introduction

In the world scenario of coffee production, Brazil is the largest producer and exporter of coffee. The State of Espírito Santo is located in the southeastern region of the country and is one of the main producers of this commodity. coffee crop This Brazilian state uses circa 170 thousand hectares to cultivate Arabica and Conilon coffee in 2021, resulting in a total production of approximately 850 k tons (Conab, 2021). Most coffee farms in this state fit the definition of family-based agriculture (Law 11,326, July 24, 2006), a sector responsible for a large part of the rural Brazilian economy. The main characteristic of the Arabica coffee cultivation system in the region of the geographical indication (GI) Café Montanhas do Espírito Santo is that it is carried out in sloping areas at altitudes from 500 to 1,200m; the soils in this region are acidic and have low natural levels of nutrients; many producers still practice the traditional method of cultivation, very dependent on inputs, chemical fertilizers, and pesticides. In many cases, when these additives are used inappropriately, they can cause environmental impacts, and contamination of soils, water, and air, in addition to causing pest/disease resistance and increasing greenhouse gas emissions (Rosset et al., 2014; Dias et al., 2020; Krohling et al., 2021; Souza et al., 2021; Seag, 2022).

For an activity to be considered sustainable, it needs to guarantee a financial return without neglecting the importance of environmental preservation and respect for human dignity. Valuing the concept of sustainability, it is necessary to adopt a set of environmental actions capable of meeting the needs of the present generation, without affecting the possibility of future generations meeting theirs. Sustainability, therefore, includes actions in several areas, mainly on the economic, environmental, and social axes. (Fao 2014; Martinuzzo et al. 2021). In the coffee-growing panorama in the state of Espírito Santo, it appears that the concepts of sustainability are not still widespread. Several agricultural technologies are capable of raising productivity levels; however, the disorderly exploitation of these techniques makes the regional coffee production process unsustainable. Thus, it is necessary to encourage coffee growers to assume their responsibility in the production chain and adopt sustainability advances in their coffee plantations (Greenberg, 1997; Deponti, 2001; De Muner et al., 2019; Verdin Filho et al., 2019).

Despite its extreme importance, the assessment of sustainability in coffee farming is still a great challenge due to the complexity of the aspects involved. Carrying out the sustainability assessment offers an analytical framework for studying and comparing different systems and farms, identifying problems and assisting in strategies that improve farm performance, promoting behavioral change involving motivation, increased satisfaction, and worker involvement, resulting in an impact directly on production processes and product quality (Masera et al., 2008; Castro et al., 2018; De Muner et al., 2019). For this evaluation, the "System for the Evaluation of Sustainability Indicators for Coffee Growing in Espírito Santo" helps in measuring the levels of economic, environmental, and social adequacy, through indicators selected based on sustainability protocols. This is an electronic spreadsheet questionnaire composed of three axes: economic, environmental, and social, each of which contains 12 assessment items (Martinuzzo et al., 2021). Several studies of sustainability assessment in coffee farming have been carried out in several countries using the concepts of sustainable development, seeking to identify the economic, social, and environmental reality of the workers involved with the coffee activity. As an example, we can mention the cases in Ethiopia, Tanzania, and Vietnam, thus emphasizing the importance of this work in the development of sustainable coffee production at a local and global level. (Ho et al., 2018; Kangile et al., 2021; Winter et al., 2022).

The objective of this work was to carry out an integrated case study aiming to characterize the economic, environmental, and social reality of different farms in the municipality of Conceição do Castelo, in the state of Espírito Santo, Brazil, in order to generate the initial benchmark for the sustainability of Arabica coffee farms. Based on this, generate research, technical assistance, and rural extension interventions aiming at improving the level of adequacy of farms to sustainability indicators.

2. Methodology

2.1 Sustainability assessment

The methodology adopted for evaluating the farms followed the recommendations of the System for the Evaluation of Sustainability Indicators for Coffee Growing in Espírito Santo, Brazil which is an instrument in the form of an electronic spreadsheet developed to assist in measuring the levels of socioeconomic and environmental adequacy. The three farmers were interviewed according to the system, through the presentation of documentation and visual observation (Martinuzzo et al., 2021).

In the economic axis, the efficiency indicators of crop productivity were evaluated; coffee marketing efficiency; coffee quality management; production cost and revenue management; soil analysis; leaf analysis; soil conservation; integrated pest and disease management; irrigation; good harvest and post-harvest practices; traceability of coffee bean production and storage.

In the environmental axis, the criteria were the acquisition of pesticides, use of personal protective equipment (PPE); return of crop protection packaging; pesticide storage; adoption of practices to protect spring areas; correct disposal of waste; licensing of agricultural activities required by law; management of solid and liquid waste produced on the farm; regularization of the legal reserve and permanent protection areas in accordance with environmental legislation (CAR); domestic sewage system in all relevant houses and structures on the farm; illegal hunting, fishing or trafficking of wild animals and plants; use of burning without authorization from the competent public department.

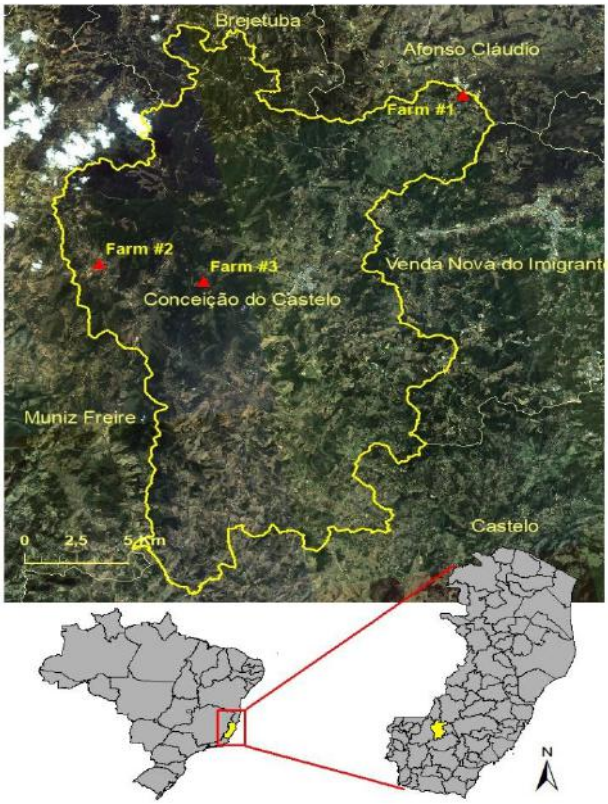
In the social axis, the evaluation followed the indicators of training of pesticide applicator; training for brush cutting/slicing machine operator; chainsaw training; machine and agricultural implement operator training; employees are registered in accordance with Brazilian labor legislation; child labor; forced labor; risk conditions; freedom of organization of employees and partners; market-compatible wages; access to education; access to the health service.

2.2 Location of the study area

Data collection was carried out on three farms in the municipality of Conceição do Castelo (Figure 1), in the state of Espírito Santo, Brazil, from February to October 2021. The farms sampled are located in the communities of Mata Fria (1,080 m altitude), Monforte Frio (715 m altitude), and São Bento de Cima (1,075 m altitude).

The municipality of Conceição do Castelo has an area of approximately 370 km² and coffee is the main agricultural activity, being the main source of income on most rural farms. In the last Brazilian agricultural census, this municipality had about 600 farms producing Arabica coffee and 360 farms producing Conilon coffee (IBGE, 2017; PMCC, 2022). Therefore, this municipality demands sustainability incentives related to coffee production, thus justifying its choice for the development of the research.

Figure 1 – Map of the location of coffee farms according to geographic coordinates, altitude and community, municipality of Conceição do Castelo, State of Espírito Santo, Brazil. 2022.



Source: Authors. Prepared by Cecília Uliana Zandonadi (2022).

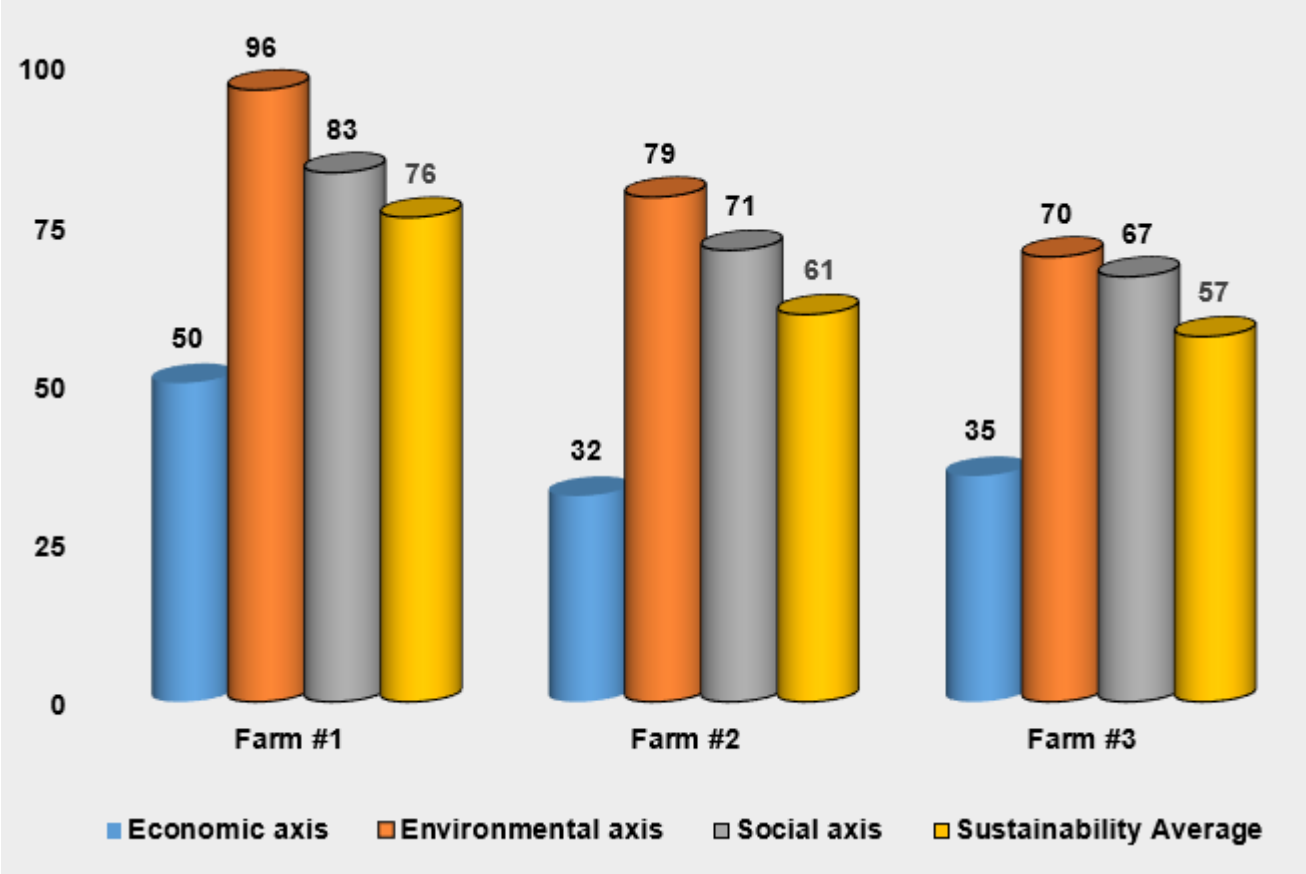
2.3 Farms' selection criteria

The farms' selection criteria sought to prioritize coffee growers who still do not practice the production of specialty coffees. Thus, the aim is to know the current situation of cultivation and encourage the production of superior quality coffees, in addition to introducing the principles of sustainable development on these farms. Superior coffees are considered special for several reasons, such as sensory characteristics, natural and anthropic factors, in addition to local customs and cultures. Thus, the different conditions chosen are justified by the uniqueness of each region (Dias et al., 2020; Souza et al, 2021).

3. Results

The results showed a lag in the three axes evaluated in all the farms sampled. It was observed that in the economic axis the scores ranged from 32 to 50 points. For the environmental axis, the scores ranged from 70 to 96 points. In the social axis, the scores ranged from 67 to 83 points. The average sustainability score of the three farms were 76, 61, and 57 points (Figure 2).

Figure 2 – General sustainability indicators of the three farms evaluated and average scores for the economic, environmental and social axes. Municipality of Conceição do Castelo, Espírito Santo, Brazil. 2021.



Source: Authors.

3.1 Farm #1

Figure 3 presents the results of each indicator evaluated on the farms. In farm #1, a score of 50 points was assigned to the economic axis (Figure 3A), with maximum scores (100 points) in the indicators of irrigation, soil conservation, integrated pest and disease management, harvest, and post-harvest and storage. The commercialization of production and soil analysis obtained scores of 75 points. The management of costs, income, and expenses obtained 50 points. For the indicators of production traceability, quality management, leaf analysis, and production efficiency, scores 0 (zero) were assigned.

This farm showed the best scores on the environmental axis (Figure 3B) reaching 96 points. Maximum scores (100 points) were obtained in the indicators of solid and liquid waste management generated by production on the farm, sewage system in all houses and relevant structures on the farm, non-practice or permission of illegal hunting, fishing, or trafficking of animals and wild plants, non-practice of burning without authorization from the competent body, adoption of practices for the protection of spring areas, correct disposal of waste, regularization of the legal reserve and permanent protection areas in accordance with the environmental law (CAR), indicators of acquisition of pesticides, use of personal protective equipment (PPE), return of empty pesticide containers and storage of pesticides. Score 0 (zero) was assigned only to the licensing of agricultural activities required by law.

In the social axis (Figure 3C), this farm obtained an average of 83 points, with maximum scores (100 points) in the indicators of access to health, education, training of pesticide applicator, training for the operator of machinery and agricultural implements (tractor driver), organization and employees and partners are in good standing with a contract, term of commitment for exchange of service or temporary service, in accordance with current labor law, child labor, forced labor, work in hazardous

conditions, freedom of organization of employees, partners and the like, employee salaries are compatible with the market. In the certification for brush cutter/trimmer operator and chainsaw training, the scores assigned were 0 (zero).

3.2 Farm #2

Farm #2 showed the lowest score on the economic axis (Figure 3D) among the others evaluated (42 points). Score 0 (zero) were assigned to the criteria quality management, leaf analysis, cost management, income, and expenses. In the indicators of soil conservation, integrated pest and disease management, production traceability, irrigation, marketing management, storage, harvest, and post-harvest, the scores obtained were 50 points. Productivity efficiency and soil analysis were the criteria that reached the maximum score (100 points).

The environmental axis (Figure 3E) was the one with the highest score for this farm (69 points) which was justified by the indicators documentation for the acquisition of pesticides, licensing of agricultural activities, legal reserve and permanent protection areas, management of solid and liquid waste generated for production, spring protection practices, non-practice or permission of hunting, fishing or illegal trafficking of wild animals and plants, non-practice of burning without authorization from the competent body, which obtained maximum scores (100 points). Note 75 was attributed only to the sewage system indicator. The indicator of adequate waste disposal obtained a score of 50 points. In this farm we observed a reduction in the score in relation to the storage of pesticides, return of empty pesticide packages, and the use of personal protective equipment, which obtained a score of 0 (zero).

In the social axis (figure 3F), this farm obtained 67 points, with the maximum score (100 points) in most indicators, including access to health, education, training for operators of agricultural machinery and implements (tractor driver), child labor, forced, working in hazardous conditions, freedom of organization of employees, partners and the like, employee salaries are compatible with the market. In the indicators of agricultural pesticide applicator training, training for brushcutter/trimmer operator, chainsaw training, organization and employees and partners are in good standing with a contract, term of commitment for exchange of service or temporary service (according to the current labor law) the scores assigned were 0 (zero).

3.3 Farm #3

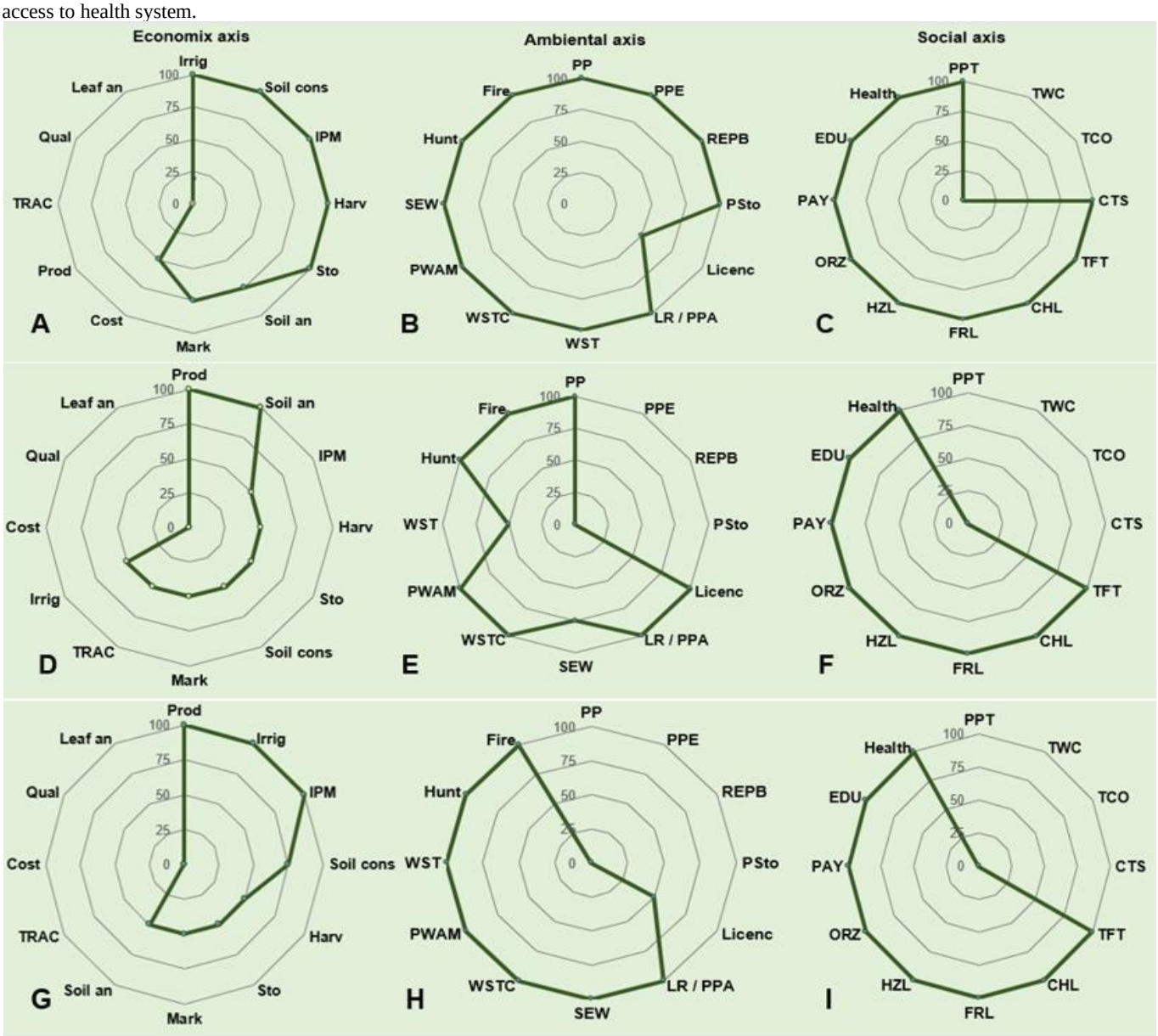
Farm #3 showed the highest score in the economic axis (Figure 3G) among the others evaluated, 54 points. Score 0 (zero) was assigned to the criteria quality management, leaf analysis, cost management, income and expenses, and production traceability. The management criteria for marketing, storage, soil analysis, harvesting, and post-harvesting were assigned 50 points. Soil conservation scored 75 points. A maximum score (100 points) was obtained in productivity efficiency indicators, irrigation, and integrated pest and disease management.

The environmental axis (Figure 3H) reached an average of 62 points. The challenges encountered by this farm were in the indicators of documentation for the acquisition of agricultural pesticides, return of empty packaging, the pesticide deposit, and the use of personal protective equipment, which obtained a score of 0 (zero). In the licensing of agricultural activities, the score was 50 points. The other indicators reached maximum scores (100 points): the legal reserve and permanent protection areas, management of solid and liquid waste generated by production, proper disposal of waste, spring protection practices, sewage system, practice or permission of hunting, fishing or illegal trafficking of wild animals and plants and non-practice of burning without authorization from a competent body.

Despite reaching the maximum score in 8 indicators, the social axis (figure 3I) of farm #3 achieved a score of 67 points, obtaining maximum scores (100 points) in the indicators of access to health, education, training for machine operators, and agricultural implements (tractor driver), child labor, forced labor, work in risky conditions, freedom of organization of employees, partners and the like and the salary of employees are compatible with the market. In the other indicators, the scores

assigned were 0 (zero), being the training of pesticide applicator, training for brushcutter and shredder operator, chainsaw training and contract of employees and partners are in good standing, term of commitment for service change or temporary service, in accordance with current labor law.

Figure 3 – Evaluation of the standards of the economic, environmental, and social axes of the evaluated farms #1 (A, B, C), #2 (D, E, F) and #3 (G, H, I). Conceição do Castelo, Espírito Santo State, Brazil, 2021. Prod - crop productivity efficiency; Mark - marketing efficiency; Qual - grain quality management; Cost - costs and incomes management; Soil an - Good Agricultural Practices (GAP) of soil analysis; Leaf an - GAP leaf analysis; Soil cons - GAP soil conservation; IPM - GAP integrated pest and disease management; Irrig - GAP irrigation; Harv - GAP harvest and post-harvest; TRAC - production traceability; Sto - coffee beans storage; PP - purchase of pesticides; PPE- use of personal protective equipment; REPB - return of empty pesticide packaging bag; PSto - pesticide storage; PWAM - protection of water source areas management; WST - correct disposal of waste; Licenc - licensing of agricultural activities as required by the law; WSTC - management of solid and liquid waste from coffee production; LR/PPA - regularization of the legal reserve and permanent protection areas; SEW - sewer system in all relevant houses and structures on the farm; Hunt - prohibition of hunting, fishing or trafficking of wild animals and plants; Fire - no use of burning without authorization from the competent bureau; PPT - pesticide applicator training; TWC - training for weed cutting machine and coffee bean picker operator; TCO - training for chainsaw operator; TFT - training for agricultural implements and machine operator (farm tractor); CTS - employees and partners have contract, term of commitment for exchange of service or temporary service in accordance with current labor law; CHL - no child labor; FRL - no forced labor; HZL - no labor in hazardous conditions; ORZ - freedom of organization of employees and partners; PAY - employees payment are suitable for the market; EDU - access to education system; Health - access to health system.



Source: Authors.

From the individual assessment of each farm, a result was generated that allows each person involved to identify the level of adequacy of the farm, working on those indicators that may have fallen short of expectations. It is important to note that all axes have 12 indicators each, with scores that can reach a maximum of 100 points (Martinuzzo et al., 2021).

4. Discussion

4.1. Economic Axis

In the evaluation carried out on the farms, it was found that the economic axis presented the lowest scores compared to the other axes, and the coffee growers did not obtain maximum scores (100 points) in more than five indicators. These data corroborate the results obtained by Viçosi et al. (2022) which highlights the need for planning and control in farm management. Winter et al. (2020) noted the need for attention in relation to the adequacy of this axis; in a study carried out with small Ethiopian coffee growers, the authors found that they were also not organized in terms of optimizing profits.

The productivity efficiency indicator was evaluated by comparing the state average of the production, which is 25 bags of arabica coffee processed per ha, with the average production (ha) in each farm. The maximum score for this indicator is reached when an average is obtained above 30% of the state productivity, when the value is lower than this percentage, the final score is gradually reduced (Martinuzo et al., 2021). Productivity is directly related to the farm's profit and profitability, supporting the entire production structure. In this indicator, two coffee growers achieved the maximum score (100 points) and farm #1 scored zero. Techniques that provide increased productivity need to be encouraged and implemented. One of the tools capable of collaborating with the increase in productivity is the use of different cultivars of Arabica coffee, which present positive attributes of interest to coffee growers and to the market such as greater production, maturation, tolerance, and resistance to pests and diseases and adaptation to the climatic conditions of the different coffee regions (Rezende et al., 2010; Embrapa, 2022 a).

Another important concept is that of good agricultural practices (GMP), which covers the criteria for soil analysis, which must be carried out every year and following the technical recommendation; the soil conservation criterion, with coffee cultivation following a contour line, keeping the soil protected by vegetation cover, controlled by a brushcutter or herbicide application; the integrated management of pests and diseases, carrying out chemical/alternative control according to monitoring, using only products registered for the crop and observing the grace period; irrigation, which requires a project and management plan; leaf analysis, which must be performed every year and following the technical recommendation (Scp, 2016; Alixandre et al., 2020).

In the five GAP indicators, farm #1 stood out, reaching an average of 75 points, with maximum scores in three indicators. Farm #2 had the lowest rating, with an average of 50 points and a maximum score in only one indicator. The average of farm #3 was 65 points, with the maximum score in two indicators. Soil and leaf analysis are necessary as a routine practice in the coffee industry. Soil sampling requires criteria to better reflect the characteristics of the soil, avoiding incorrect fertilization and liming, with economic and environmental damage. Leaf analysis is important in complementing soil analysis, identifying the need for adjustments and dosage in macro and micronutrients (Rezende, 2022).

Soil conservation and recovery in coffee plantations must keep the soil protected by vegetation cover, controlled by a brushcutter or herbicide application, with conveyors in a contour line and with vegetation cover, in addition to dry boxes when necessary. In this way, it will bring as direct benefits to the economy of fertilizers, increased productivity, and longevity of production of these crops (Rocha et al., 2000; Martinuzzo et al., 2021). Several management strategies can be adopted to increase the sustainability of coffee production, such as the use of renewable natural resources, waste recycling, organic fertilization, the use of natural pesticides, biological and mechanical pest control, soil, crop diversification, intercropping, and crop rotation (Verdin Filho et al., 2019; Guerra et al., 2021).

Pests and diseases can cause significant damage to arabica coffee crops if not properly managed. Rust and coffee berry borer are the two main limitations associated with coffee in the State of Espírito Santo, making chemical control an important tool to be used to reduce pest infestation, avoid loss of beverage quality, weight reduction of grains, premature fruit drop, and losses in coffee classification (Mesquita, 2016; Fornazier et al., 2019; Alixandre et al., 2020).

Among the GAP, the adoption of irrigation, when necessary, significantly increases the productivity of coffee plantations. In addition, this practice makes it possible to produce coffee in areas that were not suitable for this cultivation (Guerra et al. 2021). It is necessary to point out that the coffee growers involved in the research are located in a region with satisfactory rainfall, and there is no need to use irrigation for Arabica coffee plantations.

In addition to GAP, another important indicator is quality management, in which it is necessary for the farm to present 50% of its production of special Arabica coffee, thus obtaining the maximum score. The three farms were evaluated with a score of 0 (zero) in this indicator since they were selected precisely because they do not produce quality coffee. In this way, it is expected that in the next evaluations of the program, the growth and potential of the quality of arabica coffee on the farms will be identified. The consumption of quality coffees is increasing, Brazil, due to its expressive production, is the only country in the world capable of meeting the global demand for quality coffees. Specialty coffees are grains free of impurities and defects that have differentiated sensory attributes, such as a clean and sweet drink, balanced body, and acidity, which enhances your drink. In addition to intrinsic quality, specialty coffees must have traceability and respect environmental, economic, and social sustainability criteria at all stages of production, thus adding value to the marketing of the product (Castro et al., 2018., Bsca, 2022).

The coffee growers had a lag in the harvest and post-harvest indicator, which is justified by the traditional management practices on the farms, highlighting that only one farm achieved the maximum score in this regard. In order to obtain the maximum score, it is essential that the farmer apply the ten essential commandments for the production, preparation, storage of coffee beans, and commercialization of quality coffees recommended by Incaper (2013). It is recommended that, on the same day of harvest, the coffee is subjected to the washing and separation process, to remove the remaining impurities and, therefore, the coffee fruits must be separated into cherry fruits, at this stage, they have higher weight and sugar contents. Green, stale, and dried fruits have a lower weight and a higher concentration of phenolic compounds, undesirable for the production of superior coffees (Alixandre et al., 2020; Embrapa, 2022 b).

When storing coffee, it is necessary to separate it into homogeneous batches according to the beverage/type, on wooden pallets, away from the wall. It is recommended to use raffia or jute bags combined with the new technologies of plastic bags (eco-bags) with coffee beans in coconut or parchment with humidity of around 11 to 12% (SCP, 2016; Alixandre et al., 2020). Farms #2 and #3 reached 50 points and farm #1 reached the maximum score in this indicator.

In the production traceability indicator, it is essential that the farmer presents the map/sketch of the farm, identification of the plots in place, and the records of the coffee lots, from harvesting to storage to obtain the maximum score in the evaluation (Sachs et al., 2019; Martinuzzo et al., 2021). The farms did not achieve satisfactory scores to these required criteria, reducing their final assessment in this item by at least half.

The production cost and revenue management indicators are the main challenges faced by the three coffee growers, in which farm #1 achieved 50 points and the other farms scored zero. Some factors directly interfere in the final result, such as the lack of control over production costs, expenses, income, and use of labor on the farm. This deficiency is justified, among other factors, by the low level of education and the lack of qualification/training in administrative and farm management activities.

Knowing the cost of production is important to carry out accurate planning of the commercialization of production, new investments, purchase of inputs, and planting or renovation of crops. Making notes of the basic items that make up the cost of coffee production, such as noting the dates, the services performed, the inputs purchased (fertilizers, chemicals, and others) and

places where they were applied collaborate for your organization. Dividing the total expenses by the number of bags produced and sold, we obtain the cost of production, a value that should help the producer in decision-making (Scp, 2016).

Another challenge faced by coffee growers is in the management of the commercialization of coffee beans, this indicator compares the sale value of the product with the annual state quotation, reaching a maximum score when the sale is greater than 30% of the quotation value. The coffee farms evaluated in this research achieved medium marks, since the inferior quality of the beans, normally Beverage Rio - Type 7, does not allow the product to be valued in the market, reducing the income obtained.

Marketing management helps the farmer to plan his sales, control his expenses, reduce the cost of production, how to protect himself from market price fluctuations and use marketing tools that make it possible to increase the average value of coffee sales (Scp, 2016).

4.2 Environmental axis

It was observed that the evaluated farms had discrepancies in the final scores, which varied between 62 and 96 points. Despite this, the evaluations showed common adaptation needs between them in relation to the deposit, acquisition, and return of pesticide packaging, proper disposal of waste, and the use of personal protective equipment. Similar characteristics were identified in works by Viçosi et al. (2022) and Kangile et al. (2021), who indicated that coffee growers are not aware of the environmental effects associated with coffee production activities, with the need for environmental education for coffee growers.

The purchase of pesticides showed that producers do not always purchase the products with a prescription and technical guidance, which zeroed the score of farm #3, which did not present the documentation required in this criterion. According to article 84 of Law 7,802, it is necessary to follow the technical guidance of a professional who prescribes the use of phytosanitary products in accordance with the technical specifications of the crop. When making the purchase, the coffee grower must follow the respective prescription, according to his prescription, with the recommendations of the manufacturer and the sanitary-environmental agencies (Alencar, 2010).

Regarding the place of storage of pesticides, it was noted that only farm #1 had the maximum score since it does not use pesticides. The other farmers store pesticides improperly, resulting in a zero score. According to the specification of NR 31 of the Brazilian Association of Technical Norms - ABNT, the storage place must be isolated, away from residences and water resources, have an impermeable floor, pesticide leakage containment system, ventilation system, natural lighting, no allow access to animals and signs with danger symbols. Pesticides must be stored separated by type (eg, herbicides, insecticides, fungicides) and cannot be kept together with food, feed, seeds, or medicines (Costa, 2019).

Regarding the return of empty crop protection packages, only farm #1 presented a document proving the return, a criterion required to obtain the maximum score (100 points). The other farms did not meet the required demands, having their scores reset to zero. Empty packages must receive the triple wash and be perforated, being returned with their respective lids. The producer must store the proof of delivery of the packages and the invoice for the purchase of the product. The use of empty agrochemical containers is expressly prohibited for any purpose (Diniz et al., 2016).

The use of PPE was one of the indicators that also presented a great need for adjustment and only farm #1 made the correct use of this equipment. PPE aims to protect workers' health and reduce the risk of intoxication resulting from exposure to agrochemicals. Labor legislation determines as an obligation of the worker the use and conservation of PPE. The great challenge, therefore, is to encourage the worker to take a training course for the correct use of PPE, keep the equipment in good condition and replace those that are damaged (Scp, 2016; Costa, 2019).

Regarding selective garbage collection, it was found that farms #1 and #3 separate the garbage, store it in a covered place and dispose of it properly, receiving the maximum score (100 points). The main challenge found in farm #2 was the fact that the public garbage collection truck does not pass in some regions of the municipality's rural areas. The management of solid

and liquid waste generated by production on the farms must also be carried out, in order to minimize impacts on the environment. All three farms received maximum marks in this regard since none of them has equipment that produces wastewater or grain husk disposal. The domestic sewage system within the farms must also receive the correct destination, being directed to septic tanks, biodigesters, or other appropriate treatment. In this research, all those evaluated met the required criteria, reaching a maximum score (100 points) in this aspect (Diniz et al., 2016; Idaf, 2022).

Agricultural activities may be subject to licensing, according to the rules established by Law 6,938/1981 and Complementary Law 140/2011. When farms do not carry out activities that require licensing, they achieve the maximum score (100 points), as was the case with farm #2. If the grower does not present the proper legalization documentation, the score is reduced, as in farms #1 and #3 (Idaf, 2022).

According to Law nº 12.651, of May 25, 2012, the farm must present the regularization of the legal reserve and permanent protection areas in accordance with the environmental law (CAR) Rural Environmental Registry, electronic registration of national scope with the agency competent environment (Snif, 2019; Idaf, 2022). The criterion for regularization of the legal reserve and permanent preservation area was evaluated based on the documentary presentation. If the farmer owns it, the score awarded is 100 points, which happened in the three farms evaluated.

For the indicator of the adoption of spring protection practices, it was observed that the good scores achieved by the farms are justified by the fact that there are no springs in their territorial dependencies, in this case, the maximum score (100 points) was assigned. In the case of the existence of springs, it is necessary to adopt practices of preservation and recovery, and some measures can be adopted, such as soil protection, enrichment of vegetation, fencing of areas, control of soil and water contamination, mainly from the water table and the restriction of access to the protection site (Carvalho, 2004).

The Espírito Santo State Law No. 6,613, of February 6, 2001, and Law No. 5,197, of January 3, 1967, determine the prohibition of hunting, fishing, or illegal trafficking of wild animals and plants in addition to illegal fire, restricting the use of burning without authorization from the competent body. In this research, the farms achieved maximum scores (100 points) for not practicing such activities (Idaf, 2022).

4.3 Social axis

The social axis showed the highest scores in the evaluation, and all farms obtained scores above the average, ranging between 67 and 83 points, corroborating the results of Viçosi et al. (2022). In the three farms evaluated, the main indicators that contributed to these high scores (100 points) were in relation to the absence of children, forced or hazardous labor, freedom of organization of employees, salaries of employees are compatible with the market, access to education, access to health services. Salazar et al. (2018) highlight that coffee-growing is a cultural issue, therefore, the values of the family-owned, as well as its limitations, must be respected.

Em relação ao critério de funcionários e parceiros em situação regular, vale destacar que somente a farm #1 alcançou 100 pontos, uma vez que trabalha com agricultura familiar e independe de mão de obra externa. Os demais entrevistados não apresentaram a documentação exigida de contrato de parceria, ou contratação de diárias, reduzindo sua nota. O empregador, seja ele pessoa física ou jurídica, deve contratar seus empregados de forma legal, por meio de contrato e carteira de trabalho assinada, tanto para os funcionários fixos quanto os temporários, perante as Leis nº 5.889/1973, 9.300/1996 (SCP, 2016).

Regarding the criterion of employees and partners in good standing, it is worth noting that only farm #1 achieved 100 points since it works with family farming and is independent of external labor. The other interviewees did not present the required documentation of a partnership agreement, or hiring of daily rates, reducing their score. The employer must legally hire its employees, through a contract and a formal contract, for both permanent and temporary employees, in accordance with Laws 5.889/1973, and 9.300/1996 (SCP, 2016).

In the training indicators, both for the application of pesticides, and for the brush cutter, coffee bean picker, and chainsaw operator, the coffee growers did not present satisfactory scores, since for these items it is necessary to prove the training through the presentation of certificates, which is not the reality of the interviewed. It was observed, therefore, that most farmers use this equipment without the necessary training, based on their own experience and need within the farm. As for the training of operators of agricultural machinery and implements, proof with the certificate is necessary when there is an agricultural tractor on the farm, otherwise, the score is a maximum score (100 points), which occurred in the three farms evaluated. The National Rural Apprenticeship Service aims to contribute to the education and training of people in rural areas. One of the trainings offered is the Application of Agricultural Pesticides, in which it is possible to learn about the technology from understanding labels and package inserts, passing through the preparation of the mixture to the correct disposal of product residues. In addition, it is possible to understand the importance of using PPE in the application of pesticides, regulations, and levels of protection of clothing (Senar, 2022).

From the final evaluation of the three axes, it is possible to verify the current level of suitability of the farms in terms of sustainability. The coffee growers obtained scores that varied between 59 and 76 points, showing different levels of suitability for each condition. It is evident, of course, that the indicators of the economic axis, as a whole, affect the final score of adequacy in sustainability, followed by the socio-environmental indicators, which also showed a lack, although in smaller proportions. The data presented demonstrate the existence of similar patterns of behavior regarding sustainability indicators in the coffee farms sampled in the Mountains region of the State of Espírito Santo. Therefore, efforts are needed to sustain the positive effects of sustainability, so that incentive programs are considered an effective alternative to make coffee farming more sustainable (Ho et al., 2018).

Understanding sustainability is to interrelate environmental, economic and social aspects in a dynamic way. It is not about reaching a pre-defined ideal state, but about continuous change. Thus, both the objectives outlined and the path chosen to achieve them are fundamental for maintaining and increasing sustainability (Masera, et al. 2008).

5. Conclusion

The proposed methodology proved to be efficient in diagnosing the level of economic, environmental, and social adequacy of the farms.

Different interventions and adaptations need to be used so that farms reach better levels of adequacy according to sustainability criteria.

Individualized adjustments must be made on each farm; however, the values of the families and their limitations must be respected, especially the economic, social, and cultural conditions.

The three coffee farms studied need adjustments for the production of specialty coffees, mainly related to economic criteria. In this way, farms will be able to reach new markets, add value to coffee beans, increase farm income and develop sustainability.

Other studies must be developed in order to characterize more comprehensively the Arabica coffee growing farms in the region under study, with coverage the Geographical Indication 'Café Montanhas do Espírito Santo' aiming to propose general measures to mitigate economic, environmental, and social aspects. This type of study is necessary to improve the understanding of coffee farm sustainability and to allow third part coffee certification.

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