

## SUSTAINABLE ADEQUACY NEEDS FOR SMALL COFFEE FARMS IN THE MOUNTAIN OF ESPÍRITO SANTO STATE, BRAZIL

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**ABSTRACT-** Mountain coffee farms still concentrate their production on low-quality coffees, needing to encourage principles of sustainable development with standards in the three axes to allow more retention of man in the countryside and the improvement in quality of life. This research aimed to generate a benchmark for the sustainable adequacy of farms in both municipalities Marechal Floriano and Venda Nova do Imigrante, Espírito Santo State, Brazil. The research was carried out under field conditions, in six farms in different altitudes, and communities of two municipalities of Espírito Santo State, Brazil. The evaluations were done on the economic, environmental, and social axis of sustainability according to the Coffee Sustainability Standards Evaluation System. The small coffee farms showed an intermediate adequacy level when using sustainability standards. Different intervention methods must be carried out to adapt properties to sustainable principles, mainly related to economic standards. The social axis was the most adjusted to standards, mainly on the use of family labor. The environmental axis needs more adjustments in training and qualifications. Intervention actions may be offered through technical assistance to farmers, respecting the owner's family values, and their cultural and economic restrictions, to meet the particularities of each property. This research contributes by pointing out the main bottlenecks for the necessary economic, social, and environmental adaptations of rural properties in the sampled municipalities.

**KEYWORDS:** Arabica coffee, Economic and socio-environmental standards, Sustainable development.

**RESUMO-** As propriedades de café da região de montanha ainda concentram sua produção em cafés de baixa qualidade, necessitando incentivar princípios de desenvolvimento sustentável com padrões nos três eixos para permitir maior permanência do homem no campo e a melhoria da qualidade de vida. Esta pesquisa teve como objetivo gerar um benchmark para a adequação sustentável de propriedades rurais nos municípios de Marechal Floriano e Venda Nova do Imigrante, Espírito Santo, Brasil. A pesquisa foi realizada em condições de campo, em seis propriedades, em diferentes altitudes e comunidades, de dois municípios do Estado do Espírito Santo, Brasil. As avaliações foram feitas nos eixos econômico, ambiental e social da sustentabilidade de acordo com o Sistema de Avaliação dos Padrões de Sustentabilidade do Café. As pequenas propriedades cafezeiras apresentaram nível de adequação intermediário na utilização dos padrões de sustentabilidade. Diferentes métodos de intervenção devem ser realizados para adequar as propriedades aos princípios sustentáveis, principalmente relacionados aos padrões econômicos. O eixo social foi o mais ajustado aos padrões, principalmente quanto à utilização de mão de obra familiar. O eixo ambiental necessita de mais ajustes nos itens de formação e qualificação. As ações de intervenção poderão ser oferecidas

por meio de assistência técnica aos agricultores, respeitando os valores familiares do proprietário e suas restrições culturais e econômicas, para atender às particularidades de cada propriedade. Esta pesquisa contribui apontando os principais gargalos para as necessárias adaptações econômicas, sociais e ambientais das propriedades rurais nos municípios amostrados.

**PALAVRAS-CHAVE:** Cafeicultura arábica. Indicadores Econômicos e Socioambientais. Desenvolvimento Sustentável.

## 1 INTRODUCTION

Brazil leads the world coffee production, being the country that most produce and export coffee beans; it is also the second world consumer of coffee. Coffee has been relevant in the economic, social, and in cultural Brazilian aspects. The second estimate for 2023 for the Brazilian harvest of coffee species (Conilon + Arabica) indicates a total Brazilian production of 3.2 M tons. Southeastern Brazil (Espírito Santo, Minas Gerais, and São Paulo state) leads the production of Arabica coffee with ~85% of the national coffee production (Oliveira et al., 2021; CONAB, 2022).

Espírito Santo State has 2<sup>nd</sup> place in Brazilian production when considering the production of both coffee species with 32.8% of the total produced. The southern region of Espírito Santo, known as the Mountain region, concentrates most areas cultivated with Arabica coffee. Coffee growing have been for decades one of the main agricultural activities in this region where it is cultivated in steeping areas and at altitudes ranging from 500 m to 1,200 m asl. Most of these properties may be defined as family-farming (Law 11326, 2006) and are largest producer of this state's economy. The municipalities of Marechal Floriano and Venda Nova do Imigrante are part of this region and together they have ~7,000 ha of coffee in production; about 90% of the properties are small and grow coffee under the family-based production system (IBGE, 2017; PMVNI, 2022). There are still many restrictions due to difficulties in managing the crop, this mountain coffee has shown a decrease in coffee-growing areas, and need incentives to make this activity economically, socially, and environmentally sustainable (Krohling & Saraiva, 2017).

Martinuzzo et al. (2021) show that the sustainability principles, therefore, include standards in many areas, mainly in social, environmental, and economic axes. The concepts of sustainability in coffee farms need to be more widespread, mainly as a way of encouraging growers to remain in cultivation, and providing possible improvements in quality of beans (Viçosi et al., 2022; Zandonadi et al., 2022). This research was conducted to characterize the social, environmental, and economic situation aiming to generate an initial sustainability benchmark in these farms. The results showed that a range of actions in technical assistance needs to be offered to farmers to improve their compliance with sustainability standards.

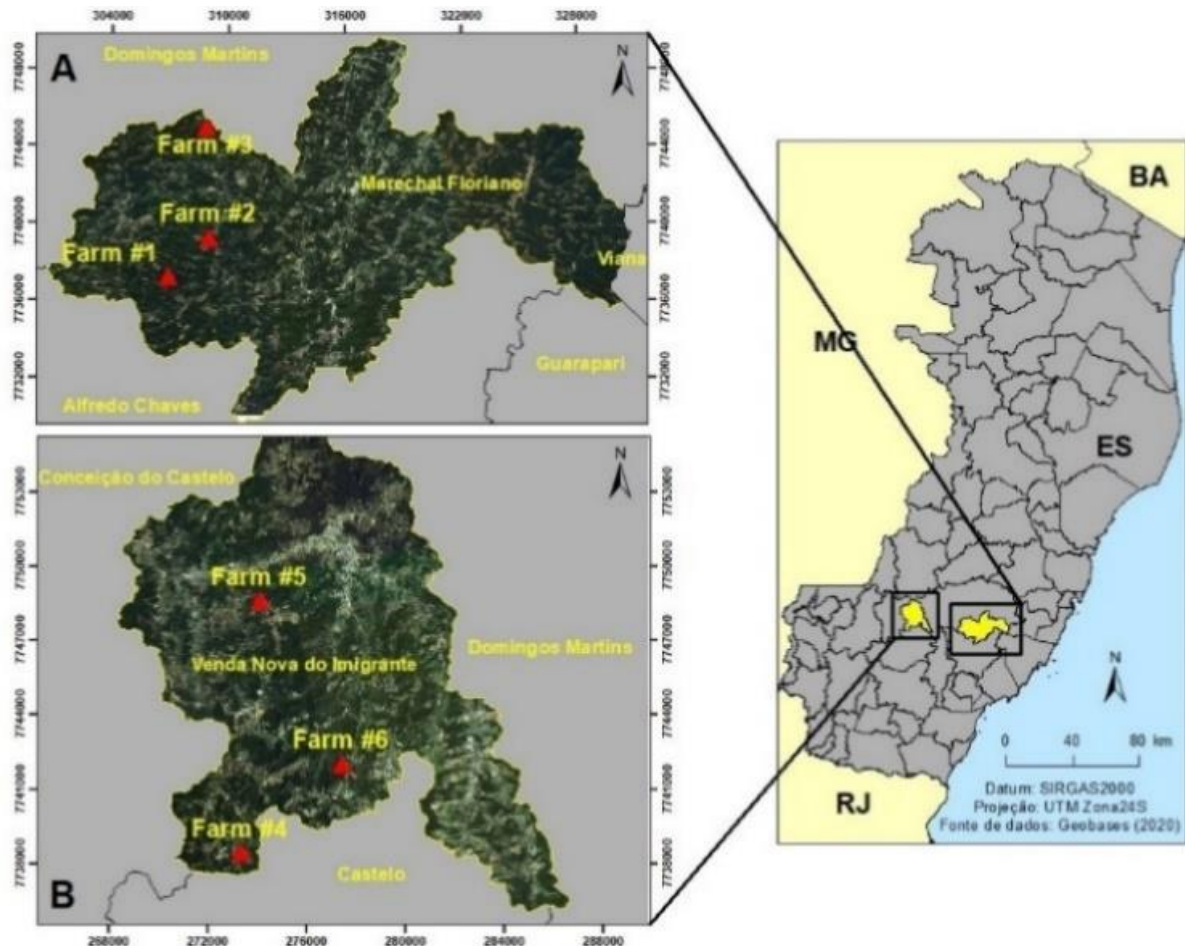
## 2 METHODOLOGY

### 2.1 Study area

The research was conducted in three farms (#1, #2, and #3) in the communities of Alto Nova Almeida (959 m altitude) and Alto Santa Maria (825 m, and 926 m), the municipality of Marechal Floriano, and three (#4, #5, and #6) at Alto Viçosinha (990 m), Bela Aurora (950 m) and São Roque (775 m), municipality of Venda Nova do Imigrante (Figure 1); these areas are included in the Mountains of Espírito Santo, Brazil. These municipalities were chosen due to their importance in this scenario of production of diverse coffee beverages, making possible highlighting the potential of these places to produce sustainable and specialty coffees and the

advantages that derive from this market. Coffee grower has been encouraged to incorporate actions to living with this new reality (CAIXETA; TEIXEIRA, 2009).

**Figure 1.** Location of the farms in the municipalities of Marechal Floriano (A) and Venda Nova do Imigrante (B) in the region of the Geographical Indication Café Montanhas do Espírito Santo, Brazil.



Source: Organized by authors, 2023.

## 2.2 Evaluation of the sustainability

The evaluations of the six farms followed the Espírito Santo Coffee Sustainability Standards Evaluation System (Martinuzzo et al., 2021), an electronic spreadsheet to measure the levels of economic, environmental, and social adequacy of farms. This worksheet was applied to the farms from March to September 2021. Third-six economic, environmental, and social standards were used. The evaluations were carried out through visual observation, and the conference of the requested documentation. The standards used to evaluate the three sustainability axes were as follow:

2.2.1 Economic axis: standards used were crop productivity efficiency (PROD), coffee marketing efficiency (MARK), coffee bean quality management (QUAL), revenue and production cost management (COST), Good Agricultural Practices (GAP) were analyzed in the GAP-soil analysis (SOIL-AN), GAP leaf analysis (LEAF-AN), and GAP soil conservation (SOIL-CONS), GAP integrated disease and pest management (IPM); GAP irrigation (IRRIG), Good Harvest and Post-harvest practices (HARV), production traceability (TRAC), and coffee-bean storage (STOCK);

2.2.2 Environmental axis: standards used were acquisition of pesticides (PP), use of personal protective equipment (PPE), return of empty pesticide packaging bag (REPB), pesticide storage (P.Sto), adoption of water sources areas management (PWAM), correct waste disposal (WST), licensing of agricultural activities (LICENC), management of liquid and solid waste from coffee production (WSTC), regularization of the legal reserve and permanent protection areas (CAR) (LR/PPA), use of sewer system in houses and other structures (SEW), prohibition of trafficking of wild animals and plants, fishing, or hunting (HUNT), and use of burning (FIRE);

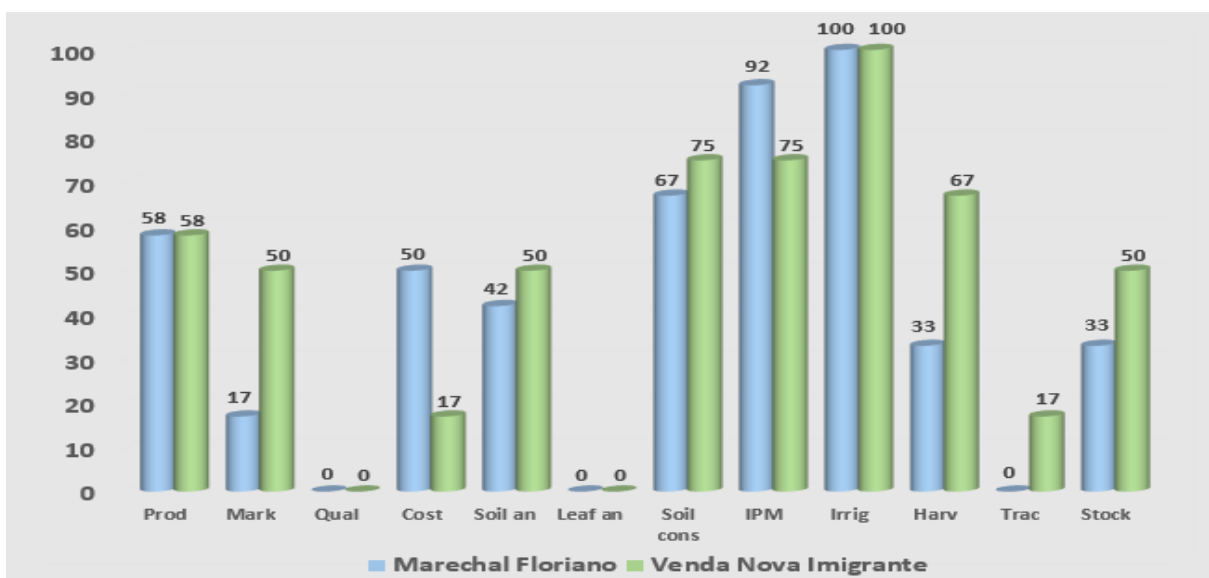
2.2.3 Social axis: standards used were the pesticide applicators training (PPT); training for coffee bean picker operator, weed cutting machine, and brush-cutter (TWC), chainsaw training (TCO), training for machine operator and use of agricultural implements (TFT), Brazilian labor legislation has been applied (CTS), child labor (CHL), forced labor (FRL), hazardous conditions in farm works (HZZL), employee’s and partners have freedom to organization (ORZ), employees payment is suitable (PAY), people have entire access to education system (EDU), and employes and their family have access to health services (HEALTH).

### 3 RESULTS AND DISCUSSION

#### 3.1 Economic Axis

The average scores of the economic axis of the six evaluated properties showed that the farms in the municipality of Venda Nova do Imigrante had a better performance in the criteria of MARK, SOIL-AN, SOIL-CONS, HARV, TRAC and STOCK, with an average score of 45.8. At the same time, Marechal Floriano reached an average of 41.7 (Figure 2). However, the farms in the municipality of Marechal Floriano were more efficient in COST, SOIL-CONS, and IPM. The PROD standards, QUAL, LEAF-AN, and IRRIG did not show differences between the sampled properties of the two municipalities.

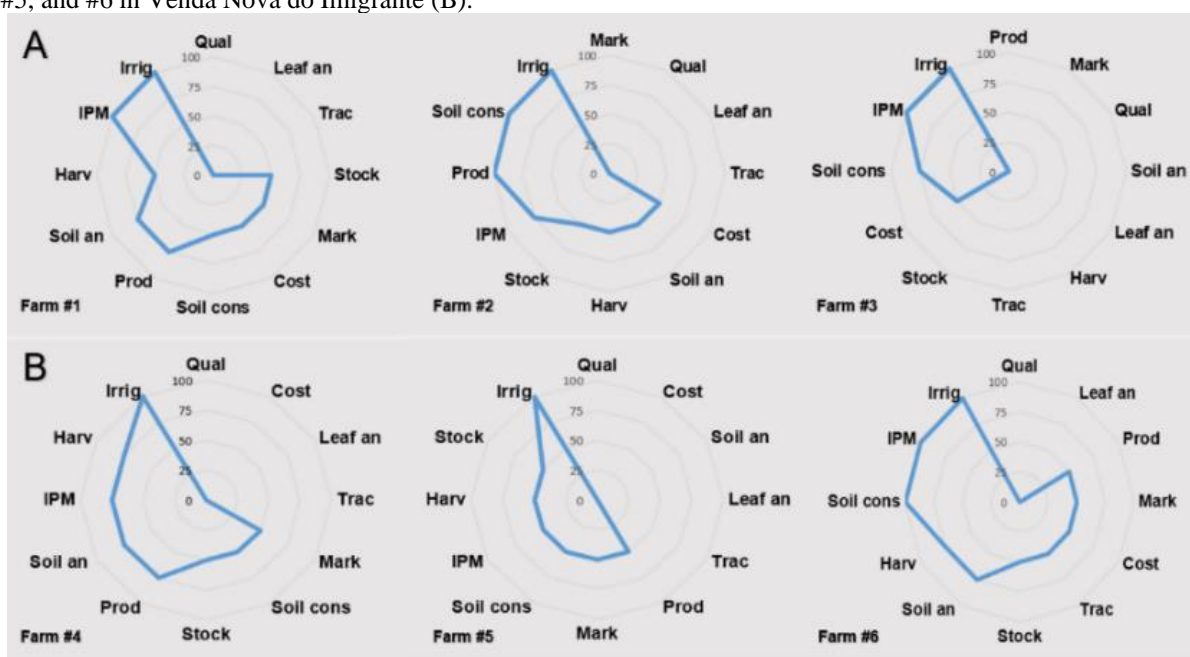
Figure 2. Average standards of the economic axis of the municipalities of Marechal Floriano and Venda Nova do Imigrante.



**Prod** - productivity efficiency; **Mark** - marketing efficiency; **Qual** - bean 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; **Stock** - coffee beans storage. **Source:** Organized by authors, 2023.

The individual scores of this axis obtained by each farm showed that all the farms evaluated in Marechal Floriano presented score zero for the standards of QUAL, LEAF-AN, and production TRAC. Divergent scores were observed in the COST and where farm #2 proved adequate (score = 100) while farm #3 was inadequate (score = 0). When we observed the SOIL-AN standard, a difference was found with farm #3 differing from the others with its total inadequacy. The IRRIG standard showed the greatest adequacy, with the three farms been adequate (score = 100) (Figure 3A). A similar situation was found in Venda Nova do Imigrante, where the LEAF-AN and TRAC standards were also inadequate (score = 0). COST and TRAC were inadequate on farms #4 and #5. In this municipality, the IRRIG standard was also fully adequate in all sampled farms (score = 100).

**Figure 3.** Economic axis standards on farms #1, #2, and #3 evaluated in Marechal Floriano (A) and on farms #4, #5, and #6 in Venda Nova do Imigrante (B).



**Prod** - productivity efficiency; **Mark** - marketing efficiency; **Qual** - bean 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; **Stock** - coffee beans storage.  
**Source:** Organized by authors, 2023.

Economic axis was the lowest adequate to the standards used among the three considered axes. Data obtained by Viçosi et al. (2022), and Zandonadi et al. (2022) in other municipalities in the same region of this Geographical Indication Mountains of Espírito Santo, also pointed out this fragility in the economic aspect of family-farms. This information points to the urgent need for changing the planning, and controlling in farm management, with the need of aggregation of technologies of GAP to improve crop productivity, post-harvest management, and the coffee marketing system. It must be considered that participation in the quality coffee market involves a series of risks, mainly due to price instability. It is one of the most important aspects, and the producers must develop a strategy for participation in market that minimizes risks and consolidates his sale, such as, for example, the execution of medium-term contracts that guarantee the profit margin. The price received by the coffee-producer needs

to cover all costs, fixed and variable; investments in technologies aimed at increasing productivity and reducing costs seem to be essential (Perosa & Abreu, 2009).

The PROD standard was measured by comparing the average productivity of each farm with the Espírito Santo state's productivity average (25 bags of processed Arabica coffee/ha). Martinuzzo et al. (2021) recommend that the maximum score must be achieved when the farm have average  $\geq 30\%$  of the state's productivity; when the farm average is lower, final score must be gradually reduced. The need for improving GAP techniques that provide increased productivity was evidenced instead just one of all farms evaluated in both municipalities showed productivity above 25 bags/ha. Factors that most interfered with the potential of coffee production were the cultivars and the spacing between rows and plants. Thus, using different Arabica coffee cultivars can be a technique capable of increasing productivity, as materials that attributes of interest to coffee producers and the market, including greater productivity, more balanced maturation, resistance/tolerance to pests, and adaptation to the diverse coffee growing regions. Another alternative is the planting density of seedlings aiming to increase productivity/ha because productivity is directly related to the economic sustainability of farms, showing the importance of this standard in farm management (Silveira et al., 2018).

The management in sale of coffee (MARK standard) reach a maximum score when the sale of Arabica coffee is greater than 30% of the market quotation; it is recommended to be calculated comparing the average sale value of the last harvest with the average price of common coffee used in the Espírito Santo state (Martinuzzo et al., 2021). Marechal Floriano' government needs to adopt an incentive practice to coffee commercialization since two farms obtained a score = 0 (zero), and one farm half the score, evidencing the need for better prices in the sale of Arabica coffee to local traders. The low evaluation in this municipality can be associated to the fact that most of the coffee-growers carry out commercialization in the local market, which does not have a variety of quality coffee traders. The low level of adoption of technologies in the production processing phase, storage, and commercialization, which provides less quality to the beverage, with unsatisfactory remuneration for coffee-growers is another factor that can difficult to value coffee beans (Alixandre et al., 2022). All farms in Venda Nova do Imigrante obtained half the score, demonstrating that these farms also need intervention and incentive actions, albeit to a lesser extent when compared to the farms from Marechal Floriano. Despite the ease of negotiation in the local market, it was observed that the three evaluated farms in Venda Nova do Imigrante need to improve the type of coffee, since the lower class of beans, beverage Rio, and coffee beans Type 7, does not allow this coffee beans to be accepted in more valuable market, reducing income obtained from the sale (SCP, 2016).

The farm requires to produce at least 50% of specialty Arabica coffee to obtain the maximum score in the QUAL standard (Martinuzzo et al., 2021). It is need to emphasize that quality refers to the production process, meeting pre-established standards through a process control system to occupy a space in the appropriated market that guarantees a differential price for less-qualified coffee. It is possible to meet the demands of consumers who seek luxury products with high added value and who use rare or specialty materials in their manufacture (Leme & Pinto, 2018). The farms received the lowest score in this QUAL standard. However, in future evaluation, it is expected that the quality potential of Arabica coffee, and the GAP will be identified, and associated with new adopted technologies. It is noteworthy that by adapting to the requirements of market niches, restricted segments of consumers are willing to pay a plus for quality, because coffee beans of this region have great possibility of winning awards in national and international coffee contests (Caixeta & Teixeira, 2009).

The COST standard is one of the principal challenges in the coffee farming of this Brazilian state. Two of the six farms had scored zero because they did not show any documentation of production cost survey; the other farms demonstrated the operating cost,

reaching 50 points. The lack of control over production expenses, revenues, and the use of mainly family labor on the property, interfere with the result of this standard that is important for carrying out planning of the bean commercialization, purchase of inputs, and planting or new investments for renovation of old coffee crops. Making notes of the dates, the services performed, the inputs purchased (fertilizers, chemical products, etc.), and where they were used can help your organization. Information on production costs is more than simple financial information, it is an effort to produce more, with more quality and less waste (Martinuzzo et al., 2021; Ferreira et al., 2022; Viçosi et al., 2022; Zandonadi et al., 2022).

Adoption of GAP is fundamental in the day-to-day coffee growing and significantly increase the productivity, making effect to the economy of fertilizers, sustainability, and lifespan of Arabica coffee crops. Soil sampling demonstrates soil fertility by accounting for the various factors required for nutrients to be absorbed by plants, such as acidity, organic matter content, and nutrient ratios. When the need for application has been established, the most recommended method for each case must be determined, whether via soil or foliar (Rezende, 2022; Ferreira et al., 2022). Aiming to complement the fertilizer recommendation based on the soil analysis, use must use de leaf analysis to proceed adjustments on the dosage in macro and micronutrients, and on the expected productivity, when necessary. However, no farm was found monitoring leaves, highlighting the necessity for more incentives for this practice. Viçosi et al. (2022) and Zandonadi et al. (2022) showed that the difficulty in realizing leaf analysis have been common in other farms. Leaf analysis shows what the plant is extracting from the soil and using it in its development; this practice should be routine and carried out annually to help the soil fertilization. The correct interpretation of the foliar analysis provides information that favors the rational use of inputs, avoids waste, improves the nutritional balance of the plants, and consequently increases productivity (Reuter, 2021; Ferreira et al., 2022).

The SOIL-CONS standard suggests that it be maintained with plant cover protection, controlled using mower or herbicide, with contour planting in addition to the use of dry boxes, (Martinuzzo et al., 2021). The use of some soil conservation measures is practiced in the sampled farms, but it can still be improved to obtain more satisfactory grades, mainly the maintenance of carriers with vegetation and in the dry boxes. Soil conservation is important because it protects the surface against the action of erosive agents, which contributes beneficially to maintaining moisture, nutrient cycling, good enzymatic activity, and stability of soil aggregates, providing the system quality (Barbosa & Benevenuto, 2021). Decreasing productivity of coffee plantations was related mainly with soil erosion. Therefore, to conserve the land and guarantee good productivity with rationality, the farmer must act in a conservationist way and thus have healthy and productive soil. The use of cover crops such as brachiaria grass (*Brachiaria decumbens*) is a viable alternative for soil cover, providing nutrients for the coffee tree with cover plant decomposition, thus increasing soil fertility and incorporating organic carbon into the soil. Increasing soil moisture retention efficiency is also essential because using cover crops, the use of pesticides to weed control is reduced (Rocha et al., 2014; Gonçalves et al., 2019).

The adequate IPM (including diseases and insects) is essential to reduce the use of chemicals, and their non-adoption can cause significant damage to Arabica coffee crops. Rust and the coffee berry borer (CBB) have been the two main concerns of coffee crop in this region, and using appropriated methods into the IPM is possible to reduce pest infestation, preventing decreasing of beverage quality, early fruit drop, and loss in the classification of coffee at sale time (Fornazier et al., 2019; Alixandre et al., 2020; Guerra et al., 2021). IPM should be chosen for increasing the environmental, social, and economic viability of family-farms. These managements consist of training the farmers to identify and quantify diseases and pests that may occur in the coffee plantation, in addition to combining methods and control strategies, such as biological, physical, mechanical, and chemical, to avoid economic, environmental, and

social damages (SENAR, 2022). Farms in Marechal Floriano carried out pest management when necessary, following monitoring, keeping application records, and using chemical or biological products intended for coffee cultivation. On the other hand, farms in Venda Nova do Imigrante were found having more difficulty in adopting chemical control/alternative monitoring of pests, mainly due to the technical assistance deficiency.

A lag in the HARV standards was found in the farms, which may be related to the traditional management practices learned with the ancient relatives. The ten essential commandments for production, preparation, storage of coffee beans, and marketing for quality coffee must be applied by coffee-growers to obtain maximum score in this standard (Incaper, 2013). The best performance observed in this standard was that of farmers from Venda Nova do Imigrante due to greater adherence to the principles for producing high quality Arabica coffee. In Marechal Floriano, greater diffusion of concepts is still needed, highlighting the wash and separation process that must be done on the same day of the beans harvest, and harvesting the highest percentage of ripe fruits. Alixandre et al. (2022) also recommended that different batches be separated for each type of beverage and that they must be dried and stored appropriately.

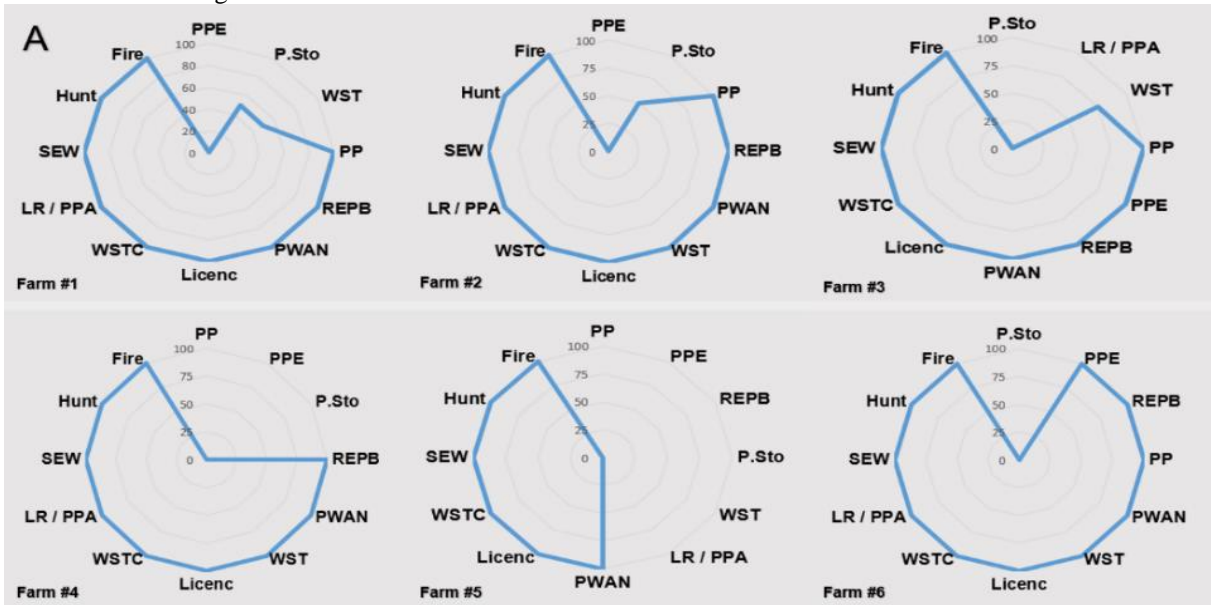
In the TRAC standard for production and storage, farmer must have the map/sketch of the coffee crop aiming to identify in which location the lots of coffee beans are coming from, since the harvest to storage. A lot of coffee must be homogeneous in relation to the drink and type, raffia or jute bags combined with new technologies eco-bags, with a humidity of around 11 - 12% and stored on wooden pallets away from the wall must be used (SCP, 2016, Alixandre et al., 2022; Martinuzzo et al., 2021). TRAC is another great challenge for coffee-growers because no satisfactory scores were found, mainly related to no identification of plots in the crop, and no map/sketch existing. Regarding STOCK, five farms scored 50, and one (farm #3) scored 0 (zero), evidencing that adjustments need to be done in relation to the storage location, following the recommended criteria to produce specialty coffees.

### 3.2 Environmental axis

The average score obtained for the standards in the environmental axis for the three farms in the municipalities of Marechal Floriano was 84, while for those in Venda Nova do Imigrante was 72.2. The six farms sampled were adequate for the PWAM, LICENC, WSTC, SEW, Hunt, and Fire criteria. Differences were observed for standards PP, PPE, REPB, P.STO, WST, and LR/PPA, and the total scores varied from 0 to 100 (Figure 4). The individualized analysis of each farm in Marechal Floriano, a variation between the scores of three indicators: PPE, P.STO, and LR/PPA where scores ranged from 0 to 100 (Figure 5A) can be observed. P.STO was not minimally adequate in all farms in Venda Nova do Imigrante, and 0 (zero) was scored. Also, variation was observed in the standards PP, PPE, REPB, and LR/PPA where the extremes of adequacy were found with scores ranging from 0 to 100 (Figure 5B).

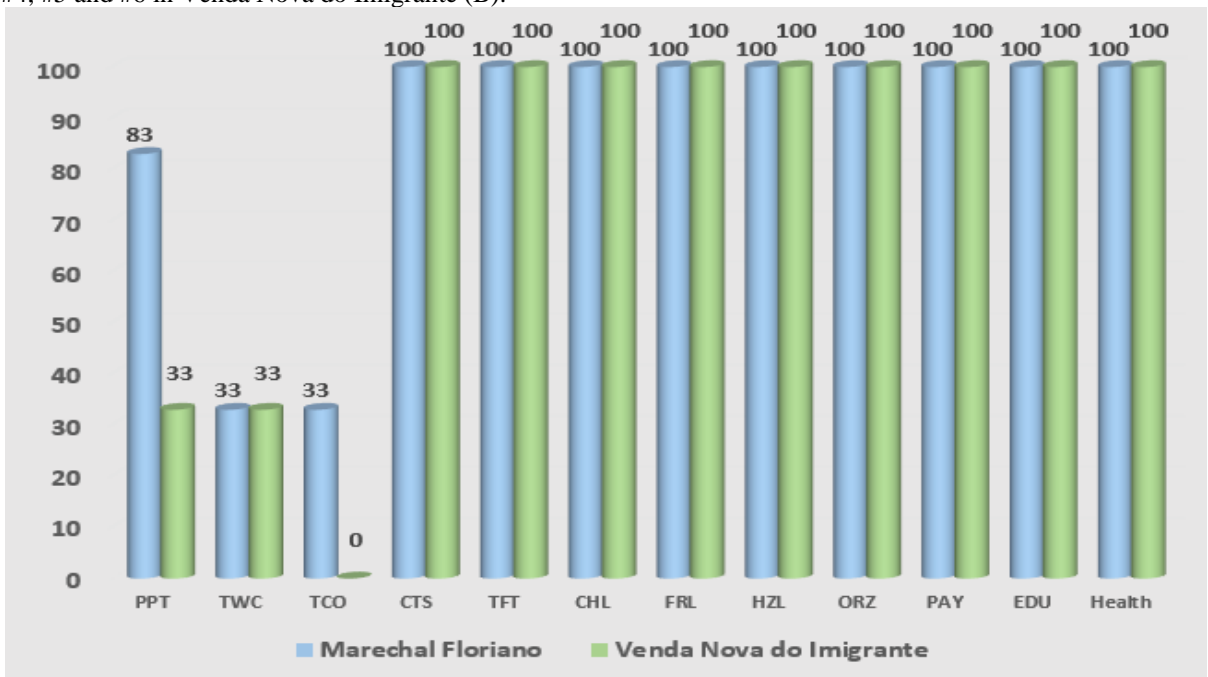


**Figure 4.** Average scores of the environmental axis indicators in the municipalities of Marechal Floriano and Venda Nova do Imigrante.



**PP** - purchase of pesticides; **PPE** - use of personal protective equipment; **REPB** - return of empty pesticide packaging bag; **P.Sto** - 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. **Source:** Organized by authors, 2023.

**Figure 5.** Environmental axis standards on farms #1, #2 and #3 evaluated in Marechal Floriano (A) and on farms #4, #5 and #6 in Venda Nova do Imigrante (B).



**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 is suitable for the market; **EDU** - access to education system; **Health** - access to health system. **Source:** Organized by authors, 2023.

Common adaptations need among the farms in both municipalities regarding the correct use of PPE and the appropriate place for storing pesticides were pointed out. Viçosi et al. (2022) and Zandonadi et al. (2022) also found similar characteristics, and highlighted that coffee growers are not watchful of the adverse environmental effects of misuse and poor pesticide storage, with the need for environmental education activities for coffee growers. The PP standard showed that the farmers in Venda Nova do Imigrante do not always buy pesticides with a technical guidance and with the prescription (Law 7,802 article 84) (Pontin et al., 2022). The farmer must follow the respective recommendation, such as indicative of the manufacturer and of the sanitary-environmental agencies. When returning the empty packages, the containers must be triple-washed, pierced, and then returned with their lids. The farmer must keep proof of this return together with the invoice of the chemical (SCP, 2016), as done by Marechal Floriano's farmers. The farms of both municipalities need adjustments in the situation of pesticide storage, highlighting the farms of Venda nova do Imigrante in which this non-compliance with standards was more pronounced. The storage location must be isolated, and need to be away from homes and water resources; it needs to have a waterproof floor, a system to contain pesticide leaks, a ventilation system, natural lighting, do not allow access to animals and must be signed with danger symbols (ABNT, NR 31). Pesticides must be stored by type and, they cannot be kept in the same place of food, feed, seeds, or medicines (Costa, 2019). The PPE standard showed a great necessity to be adjusted, on farms of Venda Nova do Imigrante and Marechal Floriano. PPE is intended to reduce the risk of intoxication resulting from exposure to pesticides, and to protect workers' health. The use and conservation of PPE is an obligation of the worker, according to Brazilian labor legislation. Farmers must be encouraged to use, such as need to encourage workers to take a training course for the correct use this equipment, and also keep equipment in good usage conditions, and replace damaged ones (Kotz et al., 2021; Martinuzzo et al., 2021).

Good grades were achieved by the farms in the PWAM standard, and it may be justified by the fact that no water source was found in the farms. If a water source is found, preservation and recovery practices, soil protection, vegetation enrichment, control of soil and water contamination, and restriction of access to the protection site must be taken (Martinuzzo et al., 2021).

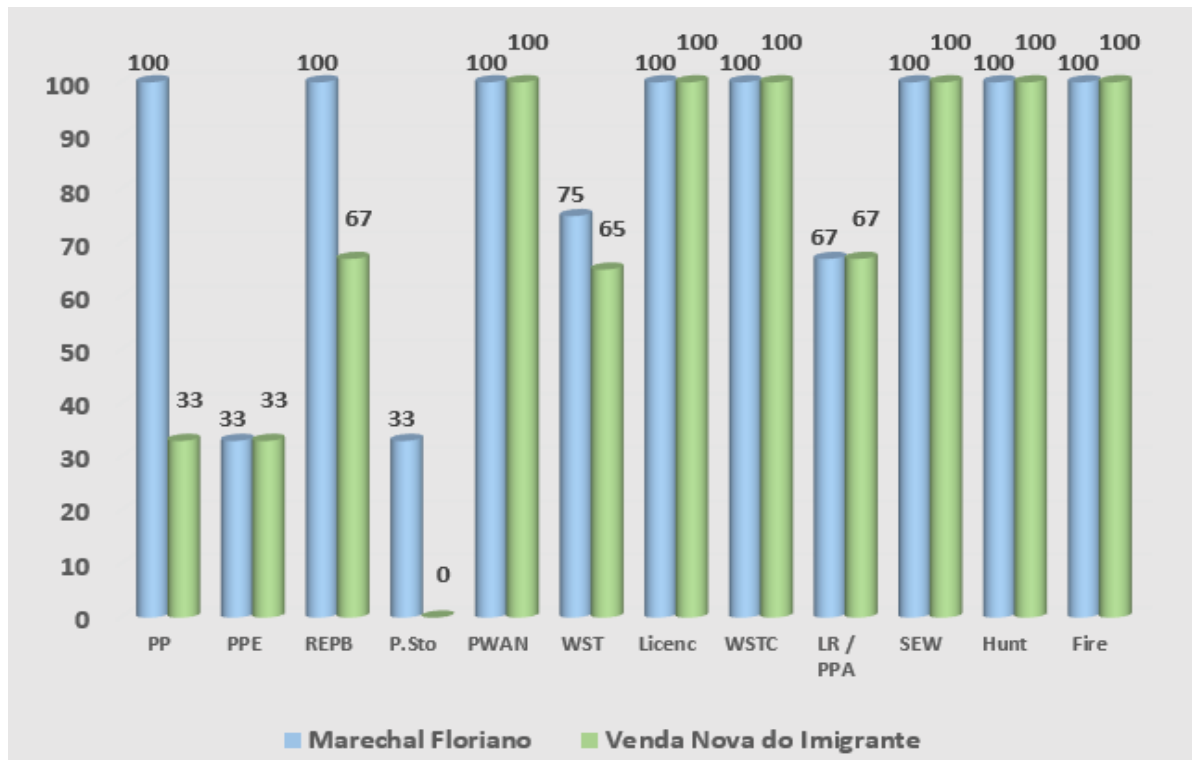
The family-farms separate and store the house waste in a covered place (WST standard). However, farms #1, #3, and #5 face the challenge that some rural communities do not have waste collection through the municipal public service. So, the family needs to carry it out to urban locations where it can be correct disposed. In addition, the domestic waste system inside the properties must also have the right destination, using septic tanks or biodigesters, as was done in all six evaluated farms. The coffee production systems generate solid and liquid waste, and it must also be discarded/treated to minimize impacts on the environment. The six evaluated farms received score 100 because none of them had equipment that produces contaminants or discards bean husks (Martinuzzo et al., 2021).

Agricultural activities must be licensed (Law 6.938/1981; Complementary Law 140/2011) (IDAF, 2022). The maximum score (100) was attributed to all farms, since the they did not have any activity that require licensing. The LR/PPA standard also requires presentation of supporting documents, and 100 was scored in four of the six farms. The property must submit the regularization of the LR/PPA (Law n° 12651, 2012) by the environmental legislation of the Rural Environmental Registry (CAR), a nationwide electronic registry with the competent environment agency (SNIF, 2019; IDAF, 2022). The standards HUNT, and FIRE are determined by State laws (Law n° 5197, 1967; Espírito Santo State Law n° 6613, 2001; IDAF 2022). The six properties were maximum scored (100) because in none of them the practice of these activities was found.

### 3.3 Social axis

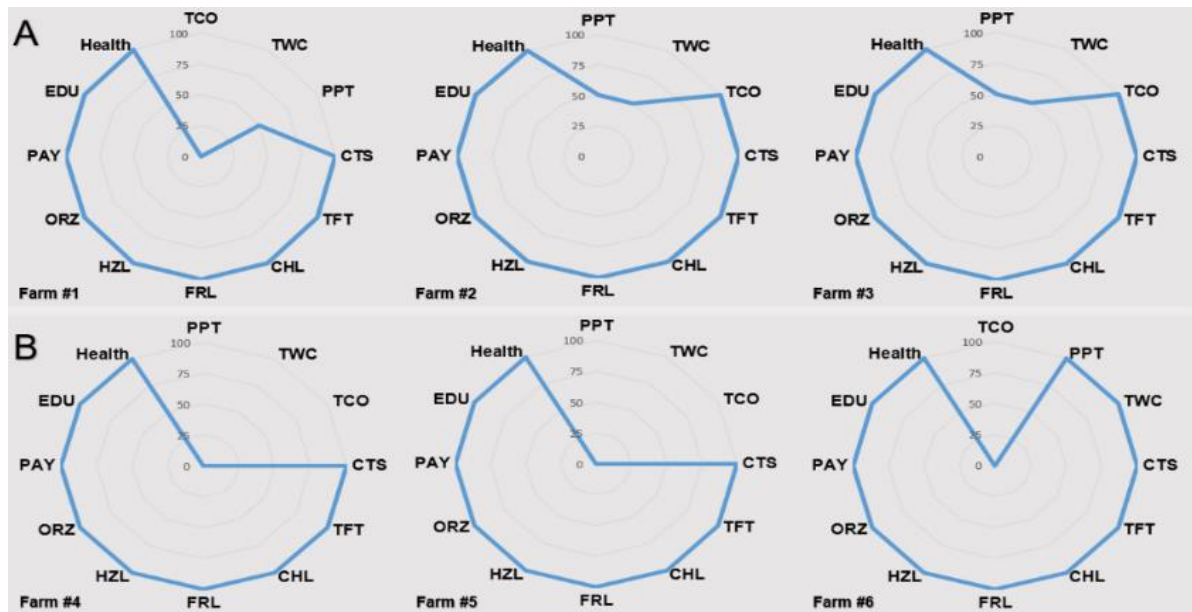
The average score of the standards of social axis of farms in Marechal Floriano was higher (87.5) than that of Venda Nova do Imigrante (80.6). The TFT, CTS, CHL, FRL, HZL, ORZ, PAY, EDU, and HEALTH indicators were fully adequate to the assessment criteria requirements, and the score 100 was marked to all farms. However, the PPT, TWC, and TCO indicators showed scores ranging from 0 to 83, requiring adjustments (Figure 6). When we observe the individualized data, it may be seemed that the most difficulty found in this axis is the training and qualifications for the use of agricultural implements. This is reflected by the TCO and TWC indicator scores, whose grades varied from 0 to 50 (Marechal Floriano) and from 0 to 100 (Venda Nova do Imigrante). PPT also showed a range of variation in NIV (0-100), being smaller in Marechal Floriano (50-100) (Figure 7A, B). The highest scores in the survey were attributed to the social axis, confirming the results also found by Viçosi et al. (2022) and Zandonadi et al. (2022). The principal standards that affected the good score were the freedom of employees to their organization, full access to education, access to health services, forced or dangerous labor, absence of children, and employee’s payment compatible with the market; maximum score was achieved to the six farms.

**Figure 6.** Average scores of the social axis standards in the municipalities of Marechal Floriano and Venda Nova do Imigrante.



**PP** - purchase of pesticides; **PPE** - use of personal protective equipment; **REPB** - return of empty pesticide packaging bag; **P.Sto** - 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. **Source:** Organized by authors, 2023.

**Figure 7.** Social axis standards on farms #1, #2, and #3 evaluated in Marechal Floriano (A) and farms #4, #5, and #6 in Venda Nova do Imigrante (B).



**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 is suitable for the market; **EDU** - access to education system; **Health** - access to health system. **Source:** Organized by authors, 2023.

When the agricultural sector is modernized, the small family-farming business has a recognized role since its uniqueness and potential are valued. Even with the presence of small machines and technologies, the improvement in production performance is pointed out since it generates jobs and plays a fundamental role in keeping people in the field (Caixeta & Teixeira 2009). However, when the pesticide application training standard was evaluated, Marechal Floriano’ farms obtained better scores when compared to Venda Nova do Imigrante, justified by the no certified training in two of the three farms in this municipality. The farms did not show satisfactory grades in the training for brush cutters and chainsaws, as these items require proof through certificates (Martinuzzo et al., 2021), and this situation was not real on farms #1, #4, #5, and #6. For the TFT standard, a certificate is only required when there the farm has a tractor; so, the maximum score was applied to all six evaluated farms.

When analyzing the CTS standard, it is worth highlighting the performance showed by farms of both municipalities, mainly because the work has been done with the family, and no external employees were found in the six evaluated farms. According to Laws 5889/1973 and 9300/1996 (SCP, 2016; Kotz et al., 2021), employees must be legally hired by employers for temporary and permanent employees, including giving a fair payment. No hazardous conditions or forced labor, and no child labor were also found. Access to health services and to the education systems also were maximum scored (100 points) on all farms. Public education is offered by the municipal government; schools and transport are offered to different groups with no discrimination by age, genera, or other granted by law. The access to the government health system is ensured by the Unified Health System (SUS, 2022), and family care is provided by public health agents in specific programs.

Using the evaluation of the three used axes, it was possible to measure the actual level of adequacy to sustainability of the sampled properties. Comparing the final score of the group

of standards, it is possible to verify that the economic axis is that with the less adequation to the standards, followed by the social and environmental axis. These two last axes also showed deficiency, although in smaller than the former. Achieving sustainability means linking economic, environmental, and social in a dynamic way. I We do not expect to immediately reach a goal, but it means a continuous change in the way of life. Thus, it is important of setting goals, but the path chosen to achieve them is also important to maintain and increase sustainability rates (Masera et al., 2008; SCP, 2016). The research demonstrated similar patterns of behavior and the level of adequacy to sustainability in both coffee-producing municipalities in the mountain region of Espírito Santo State. Thus, efforts will be needed in the three axes mentioned to improve the positive effects on farms' sustainability of local coffee growing. Other works must be conducted to expand the knowledge of the situation on sustainable development for regional farmers.

## 4 CONCLUSIONS

The general adequacy level of the evaluated farms could be considered intermediate and needs many adjustments for their adequacy to the sustainability criteria. The sampled farms need adaptations for specialty coffee production, mainly adjustments to the economic standards. The most considered appropriate axis in both municipalities was the social since they are family farms, do not depend on external labor or work contracts, and do not offer risk situations. The most considered appropriate axis in both municipalities was the social since they are family-farms, and no dependence on external labor or work contracts, and do not offer risk situations. The axis that most needs adaptations is the economic, mainly in leaf analysis, quality management standards, and production traceability. Differentiated techniques must be improved to achieve upper adequacy levels according to all the sustainability standards. Each farm must be focused on aiming to receive individualized adjustments; however, family values and limitations need to be respected mainly economically, socially, and culturally conditions. The insertion of appropriate technologies related to good agricultural practices on the field and post-harvest production system, and in the marketing of coffee will improve the quality of coffee beans, and favor exploring new consumer markets, adding value, increasing the income from farms, and developing their sustainability. The evolution of the farm's sustainability degree must be monitored so that technological re-planning can be periodically carried out, adapting them to the indicators to allow the inclusion of the farms in different third-party certifications.

## ACKNOWLEDGMENTS

To the Secretaria de Estado da Agricultura, Abastecimento e Pesca – SEAG/ES, and to the Fundação de Amparo a Pesquisa e Inovação do Espírito Santo – FAPES for the financial support of this research, and the granting of a scholarship to RCG, CUZ, and DBV (Portaria nº 002-R/2020 - Banco de Projetos de Pesquisa - SEAG, Process: 2020-CHJ7V, Termo de Outorga 581/2020); to the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural – INCAPER for the support in conducting the experimental areas and equipment available for the research.

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