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PRELIMINARY DIAGNOSTICS OF ENVIRONMENTAL SUSTAINABILITY IN GEOGRAPHICAL INDICATIONS: CONTRIBUTIONS TOWARDS A METHODOLOGY ALIGNED WITH EUROPEAN UNION REQUIREMENTS

DIAGNÓSTICO PRELIMINAR DE SUSTENTABILIDADE AMBIENTAL EM INDICAÇÕES GEOGRÁFICAS: SUBSÍDIOS PARA UMA METODOLOGIA ALINHADA ÀS EXIGÊNCIAS DA UNIÃO EUROPEIA

DIAGNÓSTICO PRELIMINAR DE SOSTENIBILIDAD AMBIENTAL EN INDICACIONES GEOGRÁFICAS: APORTES PARA UNA METODOLOGÍA ALINEADA CON LOS REQUISITOS DE LA UNIÓN EUROPEA

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Abstract

This article presents a preliminary diagnosis of environmental sustainability in Brazilian Geographical Indications (GIs), aiming to propose an evaluative instrument aligned with European Union regulatory requirements. The research distinguishes three regulatory planes: (i) environmental requirements applicable to commodity chains exported to the EU, notably the EU Deforestation Regulation (EUDR – Regulation (EU) 2023/2772); (ii) EU-specific GI protection norms, such as Regulation (EU) 2024/1143; and (iii) voluntary or strategic territorial sustainability criteria. For export-oriented GIs - particularly those linked to agricultural products such as coffee, cocoa, and beef - the EUDR constitutes a concrete regulatory requirement, with obligations for traceability and proof of deforestation-free supply chains. For export-oriented GIs operating in regulated commodity chains, market experience has consistently demonstrated that EUDR compliance is a market-access condition, not merely a competitive differentiator. A qualitative and exploratory methodology was adopted, including document analysis and application of a Multicriteria Diagnostic Protocol (MDP) to five agri-food GIs, organized into five thematic axes: natural resource management, biodiversity, climate mitigation, sustainable innovation, and

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community participation. The findings reveal localized advances in innovation and institutional partnerships, alongside significant gaps in resource monitoring, emission mitigation, and community engagement. Brazilian GIs remain at an early stage of environmental maturity. The study contributes by proposing a preliminary diagnostic instrument applicable to emerging contexts, providing support for public policy development, governance strengthening, and strategic alignment with international regulatory frameworks.
Keywords: Geographical Indications; Environmental Sustainability; European Union; Territorial Governance; Innovation.

Resumo

Este artigo apresenta um diagnóstico preliminar da sustentabilidade ambiental em Indicações Geográficas (IGs) brasileiras, com o objetivo de propor um instrumento avaliativo alinhado às exigências normativas da União Europeia. A pesquisa considera, de forma diferenciada, três planos normativos distintos: (i) as exigências ambientais aplicáveis a cadeias de commodities exportadas para a UE, em especial o Regulamento (UE) 2023/2772 (EUDR); (ii) as normas europeias específicas de proteção de Indicações Geográficas, como o Regulamento (UE) 2024/1143; e (iii) os critérios voluntários ou estratégicos de sustentabilidade territorial. Para IGs com vocação exportadora - especialmente aquelas vinculadas a produtos agrícolas como café, cacau e gado -, o EUDR representa exigência regulatória concreta, com obrigações de rastreabilidade e comprovação de ausência de desmatamento. Para as demais, as normas de sustentabilidade constituem elemento estratégico de competitividade e governança territorial. A metodologia adotou abordagem qualitativa e exploratória, incluindo análise documental e aplicação de um Protocolo Diagnóstico Multicritério (PDM) em cinco IGs agroalimentares, estruturado em cinco eixos temáticos: gestão de recursos naturais, biodiversidade, mitigação climática, inovação sustentável e participação comunitária. Os resultados evidenciaram avanços pontuais em inovação e parcerias institucionais, mas também lacunas significativas em monitoramento de recursos, mitigação de emissões e ações comunitárias. Conclui-se que as IGs brasileiras encontram-se em estágio incipiente de maturidade ambiental, e que um instrumento diagnóstico preliminar pode identificar essas lacunas e orientar a construção de uma metodologia futura validada.
Palavras-chave: Indicações Geográficas; Sustentabilidade Ambiental; União Europeia; Governança Territorial; Inovação.

Resumen

Este artículo presenta un diagnóstico preliminar de la sostenibilidad ambiental en Indicaciones Geográficas (IGs) brasileñas, con el objetivo de proponer un instrumento evaluativo alineado con los requisitos normativos de la Unión Europea. La investigación distingue tres planos normativos: (i) las exigencias ambientales aplicables a las cadenas de materias primas exportadas a la UE, en especial el Reglamento (UE) 2023/2772 (EUDR); (ii) las normas europeas específicas de protección de Indicaciones Geográficas, como el Reglamento (UE) 2024/1143; y (iii) los criterios voluntarios o estratégicos de sostenibilidad territorial. Para las IGs con

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vocación exportadora -especialmente aquellas vinculadas a productos agrícolas como café, cacao y ganado-, el EUDR representa una exigencia regulatoria concreta, con obligaciones de trazabilidad y comprobación de ausencia de deforestación. La metodología adoptó un enfoque cualitativo y exploratorio, incluyendo análisis documental y aplicación de un Protocolo Diagnóstico Multicriterio (PDM) en cinco IGs agroalimentarias, estructurado en cinco ejes temáticos: gestión de recursos naturales, biodiversidad, mitigación climática, innovación sostenible y participación comunitaria. Los resultados evidenciaron avances puntuales en innovación y alianzas institucionales, pero también brechas significativas en el monitoreo de recursos, la mitigación de emisiones y las acciones comunitarias. Se concluye que las IGs brasileñas se encuentran en una etapa incipiente de madurez ambiental, y que un instrumento diagnóstico preliminar puede identificar estas brechas y orientar la construcción de una metodología futura validada.
Palabras clave: Indicaciones Geográficas; Sostenibilidad Ambiental; Unión Europea; Gobernanza Territorial; Innovación.

1. Introduction

The growing recognition of agri-food products with territorial identity has driven the development of public policies aimed at strengthening Geographical Indications (GIs) as instruments for promoting biodiversity, traditional knowledge, and regional competitiveness. In Brazil, this movement gained momentum with the legal framework established by the Industrial Property Law (Law No. 9,279/1996), which designated the National Institute of Industrial Property (INPI) as the authority responsible for GI registration. Since then, more than 100 GIs have been recognized, the majority linked to agri-food and artisanal products. GIs have been increasingly recognized as strategic tools for sustainable rural development, enabling the valorization of products associated with local know-how and territorial culture (Barham, 2003; FAO & SINER-GI, 2009).

However, as consumer markets become more demanding with respect to traceability and supply chain sustainability, GIs must meet not only authenticity and origin criteria, but also environmental compliance and socioeconomic responsibility. In this sense, sustainability has ceased to be an optional attribute and has become a fundamental requirement for the permanence and expansion of differentiated products in international markets (Belletti, Marescotti & Touzard, 2017).

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At the international level, the Food and Agriculture Organization of the United Nations (FAO) has played a central role in formulating guidelines for origin-linked products. In partnership with the international network SINER-GI (Strengthening International Research on Geographical Indications), FAO published in 2009 the guide "Identification of Products Linked to Geographical Origin and their Potential for Development" (FAO & SINER-GI, 2009), proposing a model for GI identification and characterization based on environmental sustainability, territorial governance, and socioeconomic impact.

In parallel, the European Union has consolidated its regulatory framework through two central normative instruments that must be clearly distinguished. The first is the Regulation (EU) 2023/2772 — the EU Deforestation Regulation (EUDR) — which establishes due diligence, traceability, and proof obligations to ensure that certain commodities and products are not associated with deforestation or forest degradation after December 31, 2020. This regulation directly covers supply chains for coffee, cocoa, soy, timber, rubber, palm oil, and cattle. For Brazilian GIs with export vocation linked to these chains, the EUDR constitutes a concrete regulatory requirement, not merely a voluntary one: without documentary proof of traceability and deforestation-free origin, products are barred from accessing the European market. As market experience in multiple supply chains has already demonstrated, EUDR compliance is a market-access condition, not just a competitive differentiator.

The second relevant instrument is Regulation (EU) 2024/1143, which updates the European GI protection regime for agri-food products, wines, and spirit drinks — and, under Regulation (EU) 2023/2411, for craft and industrial products. This regulation reinforces the need for GIs to demonstrate commitment to sustainable practices, including efficient natural resource management, biodiversity protection, mitigation of environmental impacts, and contribution to the circular economy. Although distinct in their objectives and scope, these instruments converge to expand environmental requirements on certified products seeking access to or presence in the European market, reinforcing the need for an integrated approach that

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incorporates sustainability as a central element of legitimacy and competitiveness (European Union, 2023).

Despite regulatory advances and the quantitative growth of Brazilian GIs, recent studies indicate that the environmental dimension remains poorly structured in the governance practices of these initiatives. Few use regulations or technical specifications include formal environmental criteria, and when they do, mechanisms for systematic monitoring or auditing are rare (Vieira & Pedreira, 2021; Souza, Silva & Pereira, 2022). This misalignment may undermine the competitiveness of Brazilian GIs in markets such as the European Union and limit their access to public policies aimed at sustainable production.

Although the international literature has advanced the discussion on GIs as instruments of sustainable territorial development (Tregear et al., 2007; Belletti et al., 2017), studies proposing operational instruments capable of measuring, in a structured and comparable manner, the environmental compliance of GIs in contexts outside the European Union remain scarce. In the Brazilian case, the absence of systematized diagnostic protocols limits the capacity to align with emerging regulatory requirements, highlighting a methodological gap that this research seeks to address.

The challenge, therefore, is to build instruments capable of diagnosing the environmental compliance of Brazilian GIs in relation to new international regulatory requirements, thereby promoting more robust governance aligned with the Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production) and SDG 15 (Life on Land). Based on this gap, the central research question is: how are Brazilian Geographical Indications positioned with respect to environmental sustainability criteria required by the European Union, and how can a preliminary diagnostic instrument contribute to building an evaluation methodology aligned with these criteria?

The general objective is to propose a preliminary diagnostic instrument to assess the environmental compliance of Brazilian Geographical Indications with EU

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environmental requirements, with a focus on the sustainability of productive systems, and to serve as a foundation for the future development of a validated environmental assessment methodology.

The specific objectives include:

- To systematize the environmental criteria defined in the EU regulatory framework applicable to GIs, distinguishing EUDR obligations (for commodity chains) from the sustainability norms intrinsic to GI protection;
- To map the environmental aspects currently addressed by recognized Brazilian GIs;
- To develop a preliminary diagnostic instrument based on thematic axes and indicators, structured as a questionnaire form.

The underlying hypothesis is that, despite isolated sustainability practices, the majority of Brazilian GIs do not yet possess structured environmental assessment mechanisms, and a preliminary diagnostic instrument can identify these gaps and guide the development of a future, contextually grounded methodology.

The relevance of this study is justified by the growing need to align territorial certification and valorization systems with sustainable development agendas, as well as by the commercial opportunities available to those who adapt to international regulatory requirements. Furthermore, by proposing a preliminary diagnostic model, the study aims to contribute to the institutional strengthening of Brazilian GIs, informing public policies and governance strategies more aligned with sustainability (Tregear et al., 2007).

This article contributes to the field of sustainable territorial governance by operationalizing international environmental criteria into evaluative indicators applicable to Brazilian Geographical Indications, proposing a preliminary instrument with potential for replication and refinement in future studies.

2. Revisão da Literatura

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Geographical Indications (GIs) constitute one of the most important instruments for the protection and valorization of territory-linked products, associating quality, reputation, or other specific characteristics with geographic origin. Since the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), established by the World Trade Organization (WTO) in 1994, GIs have been internationally recognized as legitimate forms of intellectual property with economic, cultural, and environmental value (WTO, 1994).

In Brazil, GIs are regulated by Law No. 9,279/1996 (the Industrial Property Law), administered by the INPI, and classified under two modalities: Indication of Origin (Indicação de Procedência – IP) and Designation of Origin (Denominação de Origem – DO). Currently, more than 100 registrations have been granted to agri-food, artisanal, extractivist, and industrial products, with a concentration in the South, Southeast, and Northeast regions (INPI, 2024).

Recent studies indicate that Brazilian GIs have been assuming an increasingly strategic role in territorial development, promoting producer coordination, the valorization of local knowledge, and differentiated market insertion (Vieira & Pedreira, 2021; Flores & Falcarde, 2022). However, there is a significant gap regarding the inclusion of environmental sustainability criteria in GI management and certification systems. According to Belletti et al. (2017), the concept of "origin-linked quality" must be broadened to include environmental, social, and ethical attributes in order to ensure legitimacy before conscious consumers and regulated markets.

In this regard, the European Union has emerged as a regulatory and policy reference. For analytical purposes, it is necessary to distinguish three regulatory planes that frequently appear conflated in the literature: (i) environmental requirements applicable to commodity chains exported to the EU, represented by the EUDR (Regulation (EU) 2023/2772), which addresses deforestation and traceability obligations for products such as coffee, cocoa, soy, timber, rubber, palm oil, and cattle — constituting a market-access requirement for export-oriented GIs in these chains; (ii) EU-specific GI protection norms, such as Regulation (EU) 2024/1143, which updates the agri-food GI regime, and Regulation (EU) 2023/2411 for craft and industrial products — these instruments reinforce the need for GIs to demonstrate commitment to sustainable practices aligned with the European Green Deal; and (iii) voluntary or strategic territorial sustainability criteria, which can strengthen the competitiveness and legitimacy of GIs even when not required by specific regulation. This differentiation is fundamental to avoid misinterpretations about which obligations are compulsory and which are strategic (European Union, 2023).

Additionally, the FAO/SINER-GI methodological guide (2009) proposes a

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model for GI identification and characterization based on axes such as supply chain organization, local governance, environmental sustainability, and territorial impact. The proposal of this study dialogues with these references by developing a diagnostic methodology applied to Brazilian GIs, based on criteria and indicators that allow for the verification of alignment with new EU environmental requirements.

At the conceptual level, this study is anchored in the notion of socially constructed quality, as defended by Sylvander (2004), and in the concept of collective territorial heritage, proposed by Pecqueur (2001), which highlights the role of local governance and shared management in the sustainable valorization of origin-linked products. The articulation of these authors allows GIs to be understood not merely as reputation seals, but as integrated and sustainable development devices.

2.1 ENVIRONMENTAL SUSTAINABILITY AND THE TRIPLE BOTTOM LINE

The sustainability debate in the economic field gained prominence with the contributions of Barbier (1987), who defined sustainable development as the integration of economic growth and environmental conservation. Subsequently, John Elkington (1997) consolidated the Triple Bottom Line (TBL) concept, proposing that organizational performance cannot be measured solely by profit, but must also encompass social (people) and environmental (planet) impacts.

This conceptual model became a landmark for public policies, corporate reporting, and certifications, influencing international normative instruments such as the Global Reporting Initiative (GRI) guidelines and UN Global Compact policies (GRI, 2021; UNGC, 2015). In practice, the TBL (Elkington, 1997) suggests that organizations or productive systems can only be considered sustainable when they achieve balance across: (i) the Economic Dimension — income generation, competitiveness, and market viability; (ii) the Social Dimension — inclusion of local actors, improved living conditions, and community strengthening; and (iii) the Environmental Dimension — biodiversity conservation, rational resource use, and negative impact mitigation.

In the context of Geographical Indications, this framework is particularly relevant. GIs already partially fulfill the economic dimension by adding value to products and strengthening market competitiveness (Tregear et al., 2007). They also touch the social dimension by promoting local know-how and cultural identity (Belletti, Marescotti & Touzard, 2017). However, numerous studies indicate that the environmental dimension remains nascent (Flores & Falcarde, 2022; Vieira & Pedreira, 2021).

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Applying the TBL to GIs means recognizing that origin certification cannot be limited to a "reputation seal" or market strategy, but must integrate measurable and auditable environmental criteria. This includes, for example, the adoption of low-impact agricultural practices, water resource monitoring, carbon footprint reduction, and biodiversity area protection. It should be noted, however, that while the TBL offers an adequate conceptual structure for integrated GI assessment, its operationalization into specific indicators requires methodological adjustments depending on the institutional and sectoral context of each GI. TBL-derived indicators must be translated into concrete evidence — documentary, technical, or systematized — for the assessment to transcend the merely declaratory level.

Thus, the TBL can serve as an integrated assessment framework for future methodologies applied to Brazilian GIs, ensuring alignment with both EU regulatory requirements and global sustainable development agendas, particularly SDG 12 (Responsible Consumption and Production) and SDG 15 (Life on Land).

2.2 TERRITORIAL GOVERNANCE AND COLLECTIVE HERITAGE

The territorial development literature emphasizes that a territory's resources are not limited to isolated natural or economic factors, but constitute a socially constructed collective heritage. According to Pecqueur (2001), territory must be understood as a space endowed with specific and non-reproducible resources that acquire value through the mobilization of local actors.

In the context of GIs, the notion of collective heritage is fundamental. A GI only achieves legitimacy when territorial actors — producers, associations, public institutions, and communities — recognize themselves as co-responsible for the shared management of this common good. This collective construction process is also linked to the concept of socially constructed quality, formulated by Sylvander (2004), according to which the legitimacy of a product's quality is not merely technical, but results from social, cultural, and institutional agreements.

The territorial governance of GIs therefore goes beyond the simple administration of brand usage rules or origin seals. It involves the creation of local institutions, mechanisms for democratic participation, and practices that reinforce social cohesion. Tregear et al. (2007) highlight that GIs play a strategic role in strengthening territorial networks and building trust among actors, fostering collective innovation and long-term sustainability.

In Brazil, this aspect still faces significant challenges. Studies such as those of Vieira and Pedreira (2021) demonstrate that many GIs have governance

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concentrated among few actors or associations, with low community participation and limited integration with territorial development policies. This undermines the capacity of GIs to consolidate themselves as effective instruments for sustainability promotion.

In recent decades, GIs have also been discussed as forms of collective knowledge management, a perspective that dialogues with the theory of the commons, originally developed to analyze shared natural resources such as forests and irrigation systems (Ostrom, 1990). Recent authors have adapted the concept to the field of intellectual property, arguing that the traditional knowledge, productive techniques, and cultural practices associated with GIs constitute a type of knowledge commons (Mazé, 2023). In this study, Ostrom's principles are used as a conceptual reference to contextualize the importance of participatory governance in GIs — particularly the principles of clearly defined boundaries, participation of affected parties in rule-making, user-based monitoring, and conflict resolution mechanisms — without any claim to full analytical application, which could constitute an autonomous research field.

2.3 COMPARATIVE INTERNATIONAL EXPERIENCES

The international GI literature demonstrates that the success of these arrangements depends not only on the economic valorization of the product, but also on the incorporation of environmental sustainability criteria, participatory governance, and cultural protection. European Union countries are the leading reference in this field, having spent decades structuring public policies, regulatory frameworks, and technical support mechanisms aimed at consolidating GIs as territorial development instruments (Tregear et al., 2007; Belletti, Marescotti & Touzard, 2017).

Among the classic examples, the Roquefort Designation of Origin (DO) in France stands out, regulated since 1925 and considered one of the oldest protection models. In addition to strict criteria related to the geographic area and the use of raw sheep's milk, the DO establishes mandatory environmental management practices, such as the preservation of the natural caves used for cheese maturation. Another relevant case is Comté, also French, whose territorial governance involves hundreds of producers and cooperatives, coordinated around sustainable grazing rules, local biodiversity conservation, and restricted use of industrial feed and inputs (Barham, 2003).

In Italy, Parmigiano Reggiano is an emblematic example of the integration of cultural tradition, technological innovation, and sustainability. Beyond rigorous control of origin and productive process, the DO's governance implements circular economy

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actions, such as the use of by-products for biogas production, reducing environmental impacts and strengthening international competitiveness (Belletti et al., 2017). These cases demonstrate that the legitimacy of European GIs is strongly associated with auditable environmental protocols, community oversight, and insertion in long-term territorial policies.

In Brazil, although there are notable initiatives such as the Queijo Canastra DO and the Café da Região do Cerrado Mineiro IP, these still face structural weaknesses. The Canastra DO has consolidated itself through the valorization of artisanal know-how and cultural product recognition, but still lacks formal instruments to measure environmental impacts (Vieira & Pedreira, 2021). The Cerrado Mineiro, a reference in quality coffee, has advanced in traceability and socio-environmental certification systems, but in a still fragmented and non-mandatory manner (Vieira & Pedreira, 2021; Flores & Falcarde, 2022; Souza, Silva & Pereira, 2022; CCCMG, 2025).

The comparison between the European and Brazilian contexts highlights a fundamental difference: while in the EU environmental and social sustainability is an intrinsic part of use regulations, in Brazil these elements still appear in a fragmented and poorly systematized manner (Flores & Falcarde, 2022). This reinforces the need for diagnostic instruments to identify gaps and guide the alignment of Brazilian GIs to international standards — particularly regarding EUDR requirements for export-oriented GIs in regulated chains, and EU GI norms for GIs seeking recognition and presence in regulated European markets.

The articulation of the Triple Bottom Line theory (Elkington, 1997), territorial governance (Pecqueur, 2001), and the knowledge commons approach (Mazé, 2023; Ostrom, 1990) enables GIs to be understood as complex institutional arrangements requiring integrated evaluative instruments. The gap lies not only in theory, but in the practical operationalization of these references, particularly in institutionally developing contexts such as Brazil. This is the point at which the methodological proposal of this study is situated.

3. Methodology

The empirical object of this study is the Brazilian system of agri-food Geographical Indications (GIs), focusing on Designations of Origin (DOs) and Indications of Origin (IPs) registered with the INPI. These GIs vary widely in size and complexity, ranging from small local associations with fewer than 30 producers to more robust structures with state-wide coverage and continuous institutional support.

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Unlike a fully validated methodology, this work proposes a preliminary diagnostic instrument built from national and international technical and normative references, with a structure based on thematic axes and environmental indicators. The instrument was applied in exploratory fashion to five Brazilian agri-food GIs, aiming to identify patterns, gaps, and opportunities for improving environmental sustainability in the context of origin certification.

From a methodological standpoint, the analysis of five cases does not compromise the research objective, since this is an exploratory study focused on the development and pilot application of an evaluative instrument. As argued by Yin (2015), multiple case studies allow for the identification of analytical patterns even in reduced samples, provided the purpose is analytical rather than statistical. The responding cases were therefore treated as independent analytical units, enabling cross-case comparison and identification of structural trends.

The research is classified as applied, qualitative, exploratory, and analytical, supported by both secondary data and primary collection through a semi-structured questionnaire. The bibliographic review encompassed scientific articles, books, and national and international technical reports related to GIs, environmental sustainability, EU regulations, and territorial development. Databases such as Scopus, Google Scholar, and SciELO were consulted, along with documents from FAO, the World Intellectual Property Organization (WIPO), and the INPI.

The documentary research focused on the analysis of technical regulations, specification notebooks, INPI GI records, technical opinions, and EU normative documents. In parallel, semi-structured interviews were conducted with representatives of GI managing associations, extension technicians, and members of support bodies such as SEBRAE, Embrapa, and partner universities. Another methodological resource was participant observation, of an unsystematic nature, carried out throughout the researcher's formative trajectory.

3.1 DIAGNOSTIC METHODOLOGY

The proposed methodology is based on an adaptation of international models, particularly the framework developed by FAO/SINER-GI in the guide "Identification of Products Linked to Geographical Origin" (FAO & SINER-GI, 2009), combined with EU normative criteria (European Union, 2023). The approach combines normative content analysis, environmental indicator development, and case study application.

Methodological Steps:

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(i) Normative analysis of the EU regulatory framework applicable to GIs

A systematic reading of legal provisions addressing the environmental dimension of GIs in the European context was carried out, distinguishing: (i) EUDR obligations (Regulation (EU) 2023/2772) — traceability and deforestation-free proof requirements for agricultural commodities exported to the EU, with direct application to exporting GIs in regulated chains (coffee, cocoa, soy, etc.); and (ii) sustainability criteria of Regulation (EU) 2024/1143 — environmental practice requirements within the EU GI system. Structural criteria were extracted related to natural resource management (water, soil, energy), biodiversity conservation, emissions reduction and carbon footprint, agroecological practices, and circular economy.

(ii) Mapping of Brazilian GIs and associated environmental practices

Using the INPI database and public documents (use regulations, technical specifications, and institutional materials), the socio-environmental practices of Brazilian agri-food GIs were mapped, observing: the existence of formal environmental guidelines; recommended or mandatory practices in the productive process; environmental management plans for the supply chain; and relationships with protected areas or local natural resource use.

(iii) Construction of the Multicriteria Diagnostic Protocol (MDP)

Inspired by the "identification sheets" model of the FAO/SINER-GI guide (2009), an evaluation instrument was constructed comprising five thematic axes, as presented in Table 1. Each axis was broken down into 3 to 5 environmental indicators with scoring scales from 0 to 3, according to the following criteria: 0 — Does not comply; 1 — Partially complies (stated intent without evidence); 2 — Complies (documentary or technical evidence); 3 — Fully complies (continuous and systematized proof).

Table 1 — Methodological Matrix of the Multicriteria Diagnostic Protocol (MDP)

Axis	Indicators	Theoretical/Normative Source	Scoring Criterion	Expected Evidence per Level	Weights
Axis 1 – Natural Resource Management	Formal guidelines for water, energy, and soil management; Periodic monitoring; Producer training	FAO/SINER-GI (2009); EUDR (Reg. 2023/2772); Belletti et al. (2017)	0–3 per MDP scale	0: absent; 1: stated intent; 2: documentary record (reports, maps); 3: systematic auditable monitoring	No differentiated weighting at this exploratory stage

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Axis 2 – Biodiversity	Conservation actions; Coordination with environmental agencies; Management of native and invasive species	FAO/SINER-GI (2009); Reg. (EU) 2024/1143; Belletti et al. (2017)	0–3 per MDP scale	0: absent; 1: informal recognition; 2: documented management plans or partnerships; 3: biodiversity inventories with ongoing monitoring	Idem
Axis 3 – Climate Mitigation and Emissions	Carbon footprint reduction practices; Emissions monitoring/estimation; Low-impact input use	EUDR (Reg. 2023/2772) for exporting chains; GRI (2021); Souza et al. (2022)	0–3 per MDP scale	0: absent; 1: mention of practices; 2: emissions inventory or technical report; 3: continuous and auditable measurement protocol	Idem
Axis 4 – Sustainable Innovation in Production	Partnerships with research institutions; Environmentally focused innovations; Access to innovation programs/grants	Tregear et al. (2007); Belletti et al. (2017); FAO/SINER-GI (2009)	0–3 per MDP scale	0: absent; 1: informal partnerships; 2: documented projects; 3: measurable results applied to production	Idem
Axis 5 – Community Participation and Environmental Education	Environmental training for producers; Community education actions; Environmental issues in governance	Ostrom (1990); Sylvander (2004); FAO/SINER-GI (2009)	0–3 per MDP scale	0: absent; 1: sporadic actions; 2: documented programs; 3: systematic incorporation into governance with minutes and reports	Idem

Source: Authors' own elaboration, based on FAO/SINER-GI (2009), Regulations (EU) 2023/2772 and 2024/1143, and cited literature.

It is important to note that, at this exploratory stage, all axes receive equal weighting. Future studies may calibrate differentiated weights according to the GI's export profile, the productive chain involved, and the degree of applicable regulatory requirement. For GIs in chains regulated by the EUDR, for example, Axis 3 (Climate

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Mitigation and Emissions) and Axis 1 (Natural Resource Management) could receive greater weighting.

3.2 DATA COLLECTION INSTRUMENT

As a fundamental component of the diagnostic protocol application, a semi-structured questionnaire was developed, addressed to representatives of GI management and governance bodies in Brazil, with the objective of collecting primary data on environmental, organizational, and innovation practices. The questionnaire was structured around the five thematic axes of the MDP and organized in blocks of closed and open questions, totaling 24 items.

The instrument was sent to 18 agri-food GIs registered with the INPI, intentionally selected to represent regional (South, Southeast, and Northeast), sectoral (wines, coffee, dairy, spices, fruits), and modality (IP and DO) diversity. Of the 18 invited, five returned the questionnaire — a response rate of 27.8%. This response rate is treated in this study as a central methodological limitation (see Section 4.1 — Methodological Limitations), acknowledging that it may result from multiple factors: managerial time constraints, inadequate contact channels, low familiarity with structured environmental assessment, fear of institutional exposure, or absence of structured administrative routines. The interpretation of this rate as an indirect indicator of institutional weakness is made with caution, in light of the literature on Brazilian GI governance, and not as a direct causal inference.

The questions were formatted in different response types (multiple choice, ordinal scale, open-ended, and paragraph), aiming to capture both structured data and qualitative narratives. The questionnaire was distributed via Google Forms, enabling submission via direct links through email and messaging applications.

The conceptual validity of the instrument was ensured through direct alignment between the proposed indicators and the normative criteria established in the EU regulatory framework (Table 1), as well as coherence with the sustainability literature on GIs. Although not yet subjected to statistical reliability testing, the MDP presents sufficient internal theoretical consistency for exploratory application, as explicated in Table 1.

4. Results and Discussion

4.1 Methodological Limitations

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Before presenting the findings, it is necessary to explicitly state the methodological limitations of this study, in accordance with scientific rigor recommendations (Yin, 2015). The primary limitation lies in the 27.8% response rate (5 of 18 invited GIs). Although this rate is interpreted as a contextually relevant indicator of the degree of environmental institutionalization among Brazilian GIs, it is acknowledged that low engagement may have multiple causes, not attributable exclusively to institutional disinterest: managerial overload, inadequate contact channels, low familiarity with structured environmental assessment, or fear of institutional exposure. Inferences about the full set of Brazilian GIs must therefore be treated with caution.

The second limitation concerns non-response bias: the responding GIs may present greater engagement with environmental sustainability than the average of the Brazilian GI system, which could tend to overestimate the level of maturity observed. On the other hand, the diverse profile of the respondents — in terms of region, productive chain, and modality (IP/DO) — partially mitigates this bias. The third limitation relates to the predominantly self-declaratory nature of the data: responses were not validated by external documentation or independent auditing. In the results section, a systematic distinction is made between self-declaration without documentation, point-in-time documentary evidence, and systematic auditable monitoring.

The conclusions of this study are therefore restricted to the five cases analyzed and to the exploratory nature of the research, with no claim to statistical generalization for the set of Brazilian GIs.

4.2 Profile of Participating GIs

In order to ensure methodological transparency and allow evaluation of sample representativeness, Table 2 presents the anonymized profile of the participating GIs. It is important to clarify that "IP and DO Altos de Pinto Bandeira" and "IP Vinhos de Pinto Bandeira" refer to two distinct certifications — one Designation of Origin and one Indication of Origin — linked to the same wine-producing territory, with a single managing entity as respondent. Therefore, the unit of analysis adopted in this study is the managing entity/territory, not the individual INPI registration, which explains the coexistence of two modalities in the same case.

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Table 2 — Profile of GIs Participating in the Diagnosis

Code	Modality	Productive Sector	Region/State	Respondent Profile	Export Orientation	Notes
GI-01	IP + DO	Viticulture	Serra Gaúcha – RS	Entity manager	Yes (≈95% exports)	Dual certification; single response per territory
GI-02	IP	Viticulture	Serra Gaúcha – RS	Entity manager	Yes	Same territory as GI-01; IP modality
GI-03	IP	Artisanal cold cuts	Venda Nova do Imigrante – ES	Association representative	Not reported	—
GI-04	IP	Black pepper	Espírito Santo	Association representative	Yes (domestic and export markets)	Chain potentially affected by spice regulations
GI-05	DO	Fruit production (Fuji Apple)	São Joaquim – SC	Technical manager	Not reported	—

Source: Authors' own elaboration based on diagnostic questionnaire responses (2025). Anonymized data.

4.3 Results by Thematic Axis

The preliminary MDP application involved five Brazilian GIs: three Indications of Origin (IP) and two Designations of Origin (DO), representing different productive sectors and regions of the country (Table 2). Respondents, acting in leadership positions in their respective managing associations, reported different levels of maturity regarding environmental sustainability. It should be noted that the results presented below are predominantly based on self-declaration. Wherever possible, the level of evidence is distinguished: (a) stated intent without documentation; (b) point-in-time documentary evidence; or (c) systematic auditable monitoring.

Regarding Axis 1 — Natural Resource Management, 60% of GIs declared having formal guidelines related to sustainable water, soil, and energy management. However, only 40% conduct periodic monitoring of natural resource use, such as soil and water assessments (level b — point-in-time documentary evidence). Producer training in sustainable resource use remains irregular (level a — stated intent). As emphasized by Belletti, Marescotti and Touzard (2017), efficient natural resource

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management is one of the pillars for legitimizing environmental quality in GIs and meeting the demands of regulated markets such as Europe. The absence of monitoring mechanisms compromises the ability of GIs to demonstrate sustainable practices in a continuous and auditable manner — which would require, for instance, georeferenced maps, water use records, or soil analysis reports (European Union, 2023).

In Axis 2 — Biodiversity, only two GIs reported direct actions aimed at environmental conservation and native species management (level b). Coordination with environmental agencies is almost non-existent (level a). This indicates a weakness in the environmental governance of GIs, contrary to the recommendations of the FAO & SINER-GI guide (2009), which emphasizes the need for active territorial engagement committed to biodiversity protection. For this axis to advance to level c — systematic auditable proof —, it would be necessary, for example, to develop management plans, species inventories, and formalized partnerships with environmental agencies (Vieira & Pedreira, 2021).

With regard to Climate Mitigation (Axis 3), the data reveal the most critical area: only one GI indicated practices related to carbon footprint reduction (level a — stated intent) and none conduct emissions monitoring or estimation. For export-oriented GIs in chains regulated by the EUDR, the absence of traceability and low-emission practice documentation represents a concrete risk of market access restriction, not merely a strategic gap (European Union, 2023; Souza et al., 2022).

Axis 4 — Sustainable Innovation was the best-evaluated among the five. All GIs reported maintaining partnerships with research institutions, including Embrapa, IFES, UFRGS, IFRS, and others (level b). These collaborations, while relevant, do not always translate into applied environmental innovation. Only one GI reported effective environmentally focused innovation (no-till farming — level b/c). According to Belletti et al. (2017), innovation in GIs should be aligned with clean technologies, regenerative practices, and technical knowledge production, which still presents itself in an incipient manner.

Regarding Axis 5 — Community Participation and Environmental Education, none of the GIs conduct systematic community engagement activities (level a). Environmental training for producers occurs sporadically. According to the FAO & SINER-GI (2009) framework, the social legitimation of GIs depends on territorial education and the inclusion of local actors in the formulation of sustainable strategies. The lack of systematic actions undermines alignment with SDGs 12 and 15.

Among respondents' closing comments, strong interest was identified in adapting GIs to international norms, particularly those with export vocation. This

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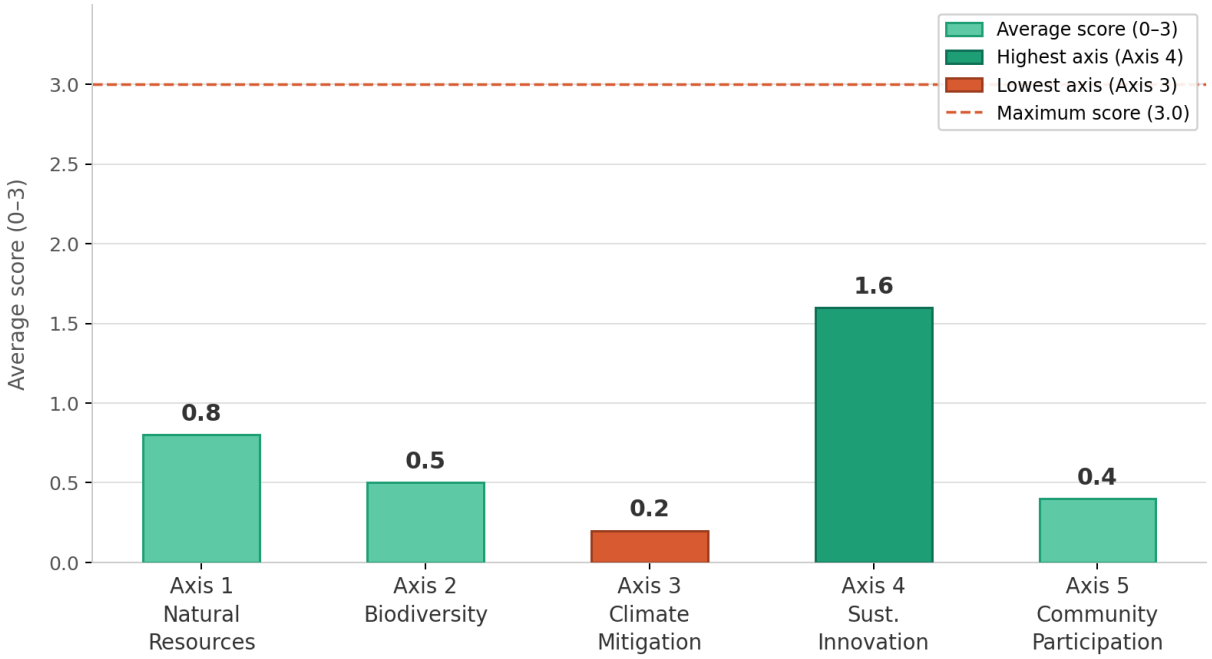
finding is particularly relevant: export-oriented GIs — such as the case of the gaúcho viticulture sector, where approximately 95% of production is destined for export markets — face distinct commercial and regulatory incentives from those focused on domestic markets. This suggests that the degree of international exposure should be treated as a moderating variable in the adoption of environmental practices in future studies.

4.4 Comparative Analysis and Interpretation

To complement the qualitative analysis and comparatively illustrate the performance of the evaluated GIs, Figure 1 synthesizes the average scores assigned across the five axes of the Multicriteria Diagnostic Protocol.

Figure 1 — Comparative environmental performance of the evaluated GIs across the five thematic axes of the MDP.



Source: Authors' own elaboration (2025). Note: Scores are based on respondent self-declaration and are exploratory in nature.

Average scores, Figure 1, were calculated based on the five case responses, assigning integer values from 0 to 3 per indicator (0 = does not comply; 1 = stated intent; 2 = documentary evidence; 3 = systematic proof), and then computing the average per axis. Axis 4 obtained the highest average (approximately 1.6), reflecting

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the presence of consolidated institutional partnerships. Axis 3 recorded the lowest average (approximately 0.2), indicating the absence of formal emissions measurement mechanisms. The chart scale ranges from 0 to 3, and the bars represent the averages of the five cases.

When contrasted with the requirements established by the EU regulatory framework, particularly regarding emissions measurement and documentary proof of sustainable practices for exporting chains, the findings indicate a significant structural misalignment. It is important to differentiate, however, between GIs in chains directly regulated by the EUDR — for which the misalignment represents an immediate regulatory risk — and those in chains not covered by the EUDR, for which the observed gaps represent primarily a competitive and territorial governance deficit.

Beyond the quantitative data, respondents' open-ended comments revealed fundamental aspects about the challenges faced. Recurring mentions were made of the lack of clear and applicable criteria, difficulty in engaging producers, and the absence of balance between conservation and production. In contrast, respondents highlighted interest in deepening the theme and recognized that collective action and coordination between public and private actors are essential for strengthening GI sustainability.

Box 1 — Qualitative comments from diagnostic participants (categorized)

Analytical Category	Respondent Comment (verbatim transcription)
Internal normative gaps	"Challenge in the absence of clear and applicable criteria in the DO rules"
Production-conservation tension	"The eternal challenge of seeking the balance between production & preservation"
Interest in deepening	"I am very interested in deepening this subject"
Individual voluntary innovation	"On an isolated initiative, I am investing with my own resources in innovative research focused on the economic, environmental, and energy sustainability of black pepper cultivation in ES"
Collective governance and cooperation	"We need to unite forces between public and private bodies; the collective effort will make all the difference for the mutual success of sustainable development" [original spelling preserved]

Source: Authors' own elaboration (2025). Comments categorized for analysis. Original spelling of respondents preserved.

From a scientific standpoint, the main contribution of this study lies in proposing a structured environmental diagnostic model applicable to GIs in emerging contexts. In summary, the results reveal both localized advances and structural gaps

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in the incorporation of sustainability by Brazilian GIs. Sustainability in these GIs still operates predominantly under a declaratory logic (level 1 of the MDP scale), with low formalization of auditable environmental metrics. This suggests that progress toward international regulatory alignment will depend not only on technical adjustments, but on the strengthening of collective governance and the institutionalization of systematic environmental routines — a condition especially critical for GIs in chains regulated by the EUDR.

5. Considerations

This study departed from the premise that Brazilian Geographical Indications, although growing and recognized for their sociocultural and economic relevance, still lack structured mechanisms for assessing, proving, and improving the environmental sustainability of their productive practices. Given the growing demands of regulated markets such as the European Union, and the global demand for fairer, more transparent, and more sustainable food systems, it is imperative that origin-certified products incorporate environmental indicators into their governance.

The Multicriteria Diagnostic Protocol (MDP) developed in this study represents an initial evaluative instrument proposal, grounded in consolidated international references (FAO & SINER-GI, 2009; European Union, 2023) and adapted to the Brazilian context. Its preliminary application, based on the analysis of five agri-food GIs from different regions and productive sectors, allowed for the identification of recurring patterns of monitoring absence, institutional disconnection, and lack of formalized environmental culture. The conclusions are restricted to this set of cases and to the exploratory nature of the research, and cannot be extended to the full set of Brazilian GIs without additional validation studies.

The evidence gathered indicates that, while some GIs present promising innovation and institutional coordination initiatives, most are still at an early stage of systematized environmental management. The lack of auditable indicators and environmental action plans may hinder the international insertion of these products, and is especially critical for those inserted in chains regulated by the EUDR.

As a practical implication, the need for expanded empirical validation of the proposed protocol is highlighted. The following recommendations are made: (i) broaden the sample with greater regional, sectoral, and modality representativeness; (ii) test the consistency and adaptability of the indicators in distinct intersectoral contexts, recognizing that GIs for wine, black pepper, and apples have very different environmental impacts and regulatory requirements; (iii) calibrate possible

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differentiated weights for the axes according to the export profile and productive chain; and (iv) submit the instrument to expert validation and formal pre-testing in future studies.

As a future research agenda, the refinement of the protocol is recommended through the incorporation of complementary social, cultural, and economic dimensions, expanding its analytical scope and application potential. The consolidation of a sustainability culture in Brazilian GIs will depend on the articulation of technical knowledge, collective governance, and institutional commitment.

By proposing a structured environmental diagnostic model applicable to Geographical Indications, this study contributes to the transition from a predominantly normative approach to an operational and measurable perspective on territorial sustainability. This represents an initial advance in the consolidation of environmental metrics integrated into the Brazilian GI system — a strategic condition for its qualified insertion into global value chains oriented by socio-environmental criteria.

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