



# Brief Notes on the European Geographical Indication Law: Among Sustainability Implications and Artificial Intelligence Applications

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**Purpose:** Geographical indications (GIs) within the European Union are – as is known – legally protected designations highlighting unique qualities of products tied to their place of origin; accordingly, GIs can promote sustainable agricultural practices, preserve traditional knowledge and contribute to rural development, but, notwithstanding, issues in verifying and authenticating GI products persist. Within this framework, this paper investigates the intersection of EU geographical indication law with sustainability goals and potential applications of artificial intelligence (AI) in streamlining GI compliance and enhancing consumer trust.

**Study design/methodology/approach:** The behind research employs a mixed-methods approach; in fact, it includes a systematic review of relevant EU legislation and policy documents alongside qualitative case studies exploring the use of AI-based technologies (e.g., precision agriculture, terroir monitoring, traceability systems...) in GI value chains.

**Findings:** The analysis confirms the wanted complex interplay between GI law and sustainability; in this way, while GIs can be powerful tools for promoting environmentally responsible production, existing frameworks may not fully capture all dimensions of sustainability; in addition, case studies demonstrate the promise of AI in improving product traceability, combating fraud and supporting informed consumer choices regarding GI products.

**Originality/value:** Therefore, the paper argues for a more holistic approach to GI law that integrates sustainability metrics beyond geographic origin, suggesting that responsible AI adoption presents the potential to significantly strengthen GI systems: policy recommendations should include incentivising the development of ethical AI solutions for GI verification, promoting data sharing along supply chains, and raising consumer awareness of the sustainability benefits associated with GI products.

## Introduction

As is known, geographical indications (GIs) within European Union law – but similarly, at the international level – represent a form of intellectual property protection aimed at legally recognising the distinctive qualities, reputation or characteristics of products inextricably linked to their geographical place of origin. Based on the above brief definition, it is already possible to understand how, far from being mere labels applied to products, GIs are intrinsically connected to the promotion of sustainable agricultural practices that respect environmental considerations, the preservation of traditional knowledge passed down through generations and the stimulation of economic growth in rural areas. Notwithstanding, the integrity of GI systems rests upon the ability to verify and authenticate GI products; this remains a complex issue, potentially undermining consumer trust in such designations.

In recent years, the potential of artificial intelligence (AI) to transform GI systems has become a focus of intense interest; in fact, AI-powered technologies promise to offer unprecedented capabilities for streamlining compliance processes, providing rigorous product traceability throughout complex supply chains and combating fraudulent practices that seek to exploit also the value of GIs. Within such a framework, the present paper argues that a fundamental, further evaluation of EU GI law is necessary to unlock the full potential of GIs; specifically, it advocates for a holistic approach that integrates broader sustainability metrics beyond simple

origin while ensuring the responsible and ethical adoption of AI innovations, considering that such an approach is essential to ensure GIs remain powerful tools for promoting a sustainable future and protecting consumer confidence.

### **EU geographical indication law and sustainability**

The EU distinguishes between three main types of GIs. The most prestigious type corresponds to the Protected Designation of Origin (PDO), which is reserved for products deeply enmeshed with their place of origin; everything about a PDO, from production to preparation, must occur within a defined geographical area, ensuring that its special qualities are completely derived from the environment around it. Similarly, Protected Geographical Indications (PGIs) require a strong link between product quality and origin but, differently, are slightly less strict in that they allow one stage of the process to possibly happen elsewhere. Instead, traditional Specialities Guaranteed (TSGs) emphasise the importance of traditional production methods or recipes; therefore, while TSG products are still connected to a specific region, their unique characteristics are not necessarily limited to or exclusively defined by the place of origin.

To earn the designations mentioned above, producers and their representative groups must meticulously document their product's specifications, how they are made and the inextricable link between the product and its specific place of origin. Applications face rigorous scrutiny by both national authorities and the European Commission; in particular, should an application succeed, the product gains extensive protection across the EU, shielding it from attempts at imitation, name misuse, or any misleading practices.

It should be noted that the EU works to secure GI recognition outside its borders through various international trade agreements; accordingly, the framework is under constant review, with the EU actively seeking ways to further strengthen and streamline it for the benefit of producers and consumers alike.

Particularly, such EU legal framework is primarily built upon six pieces of legislation, actually in force: «Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs» (<http://data.europa.eu/eli/reg/2012/1151/oj>); «Commission Delegated Regulation (EU) No 664/2014 of 18 December 2013 supplementing Regulation (EU) No 1151/2012 of the European Parliament and of the Council with regard to the establishment of the Union symbols for protected designations of origin, protected geographical indications and traditional specialities guaranteed and with regard to certain rules on sourcing, certain procedural rules and certain additional transitional rules» ([http://data.europa.eu/eli/reg\\_del/2014/664/oj](http://data.europa.eu/eli/reg_del/2014/664/oj)); «Commission Delegated Regulation (EU) 2022/891 of 1 April 2022 amending Delegated Regulation (EU) No 664/2014 supplementing Regulation (EU) No 1151/2012 of the European Parliament and of the Council with regard to the establishment of the Union symbols for protected designations of origin, protected geographical indications and traditional specialities guaranteed and with regard to certain rules on sourcing, certain procedural rules and certain additional transitional rules» ([http://data.europa.eu/eli/reg\\_del/2022/891/oj](http://data.europa.eu/eli/reg_del/2022/891/oj)); «Commission Implementing Regulation (EU) No 668/2014 of 13 June 2014 laying down rules for the application of Regulation (EU) No 1151/2012 of the European Parliament and of the Council on quality schemes for agricultural products and foodstuffs» ([http://data.europa.eu/eli/reg\\_impl/2014/668/oj](http://data.europa.eu/eli/reg_impl/2014/668/oj)); «Commission Implementing Regulation (EU) 2022/892 of 1 April 2022 amending Implementing Regulation (EU) No 668/2014 laying down rules for the application of Regulation (EU) No 1151/2012 of the European Parliament and of the Council on quality schemes for agricultural products and foodstuffs» ([http://data.europa.eu/eli/reg\\_impl/2022/892/oj](http://data.europa.eu/eli/reg_impl/2022/892/oj)); and «Commission Communication – Guidelines on the labelling of foodstuffs

using protected designations of origin (PDOs) or protected geographical indications (PGIs) as ingredients» ([https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52010XC1216\(01\)](https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52010XC1216(01)))

In this regard, it must be added – as very recent – on one side, «Regulation (EU) 2023/2411 of the European Parliament and of the Council of 18 October 2023 on the protection of geographical indications for craft and industrial products and amending Regulations (EU) 2017/1001 and (EU) 2019/1753» (<http://data.europa.eu/eli/reg/2023/2411/oj>); on the other side, the «proposal for a regulation of the European Parliament and of the Council on European Union geographical indications for wine, spirit drinks and agricultural products, and quality schemes for agricultural products, amending Regulations (EU) No 1308/2013, (EU) 2017/1001 and (EU) 2019/787 and repealing Regulation (EU) No 1151/2012» (<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0134>).

In truth, the social and environmental sustainability of agricultural production represents one of the specific objectives that the European Union declares to be pursuing through the GIs regime, in line with the Green Deal and the Farm to Fork strategy (European Commission, 2020), while the European Parliament, among other things, adds that the GIS sectors can, without any obligation, also play an important role in the development of the circular economy, in the following terms: «The collective organisation of the producers of a geographical indication can better ensure a fair distribution of the value added amongst the actors in the supply chain, to provide a fair income to producers, which covers their costs and allows them to invest further in the quality and sustainability of their products» (Amendment 8, Proposal for a regulation, Recital 9).

Accordingly, even if the existing legal framework inherently touches upon aspects of sustainability (Flinzberger L., Cebrián-Piqueras M.A., Pepler-Lisbach C. and Zinngrebe Y., 2022; Marescotti A. et al., 2020; Gocci A., Luetge C. and Vakoufaris H., 2020; Owen L., Udall D., Franklin A. and Kneafsey M., 2020; Gocci A. and Luetge C., 2020; Wirth D.A., 2016), there is significant potential to further strengthen these connections, leveraging different perspectives.

First of all, from an environmental perspective, GI specifications often encourage production methods that respect natural resources and biodiversity; notwithstanding, a greater emphasis could be placed on regenerative practices, rigorous water management, and aligning explicitly with the EU's climate goals by including targets for reducing greenhouse gas emissions (Falasco S., Caputo P. and Garrone P., 2024; Cheng D., 2023; Girard S., 2022). From a social perspective, instead, GIs undoubtedly support traditional knowledge and rural livelihoods; notwithstanding, regulations could be further enhanced to emphasise fair labour conditions, equitable benefit-sharing throughout the value chain and the inclusion of explicit social responsibility provisions within GI product specifications (Bowen S. and Zapata A.V., 2009). Furthermore, from an economic perspective, GIs offer benefits. However, current regulations might gain from provisions that encourage the inclusive participation of small-scale producers, support for producer cooperatives and mechanisms to ensure fair price distribution (Arfini, Mancini, Veneziani and Donati, 2016).

Subsequently, to fully realise the sustainability potential of GIs, the EU legal framework could consider integrating, in a structural way, broader sustainability metrics – precisely, environmental, social and economic – into the core of GI regulations. In addition, moving beyond strictly origin-based GI criteria towards a lifecycle approach, addressing environmental impacts – such as production, processing, transport and the like – would be beneficial. Finally, robust systems are needed to monitor the sustainability performance of GIs over time, ensuring continuous evaluation and improvement (Zappalaglio A., 2021).

In this regard, an excellent starting point is represented by the study Sustainable Strategy for Geographical Indications (SSGI) – as the result of the international partnership FAO-oriGIIn, created to achieve the Sustainability Development Goals (SDG) – that identifies over 400 indicators to determine, through a shared approach with the stakeholders of the sector, the state of sustainability of the supply chain and how to improve it (FAO-oriGIIn, 2024).

### **Artificial intelligence applications in geographical indication systems**

The monitoring, verification and enhancement of GI systems – as AI continues its rapid advancement – are experiencing a profound transformation; specifically, AI technologies are revolutionising diverse aspects of GIs, including agricultural practices, supply chain management, sensory analysis and quality control, generating an integration that underscores the increasing significance of AI as a key enabler for the preservation and promotion of GIs in a globalised marketplace. It may be precisely said that AI helps improve GI's effectiveness in its current application, and this effect contributes to positive outcomes, first of all in terms of identity protection and brand enhancement. Particularly, a first key area lies in the application of various machine learning (ML) techniques within agriculture, enabling data-driven insights that support the integrity and sustainability of food production: e.g., predictive models built upon ML algorithms can integrate vast datasets of environmental conditions, soil properties and cultivation techniques; analysis based on such data can pinpoint how these factors influence agri-food quality, a circumstance that is particularly valuable for verifying compliance with GI specifications. ML can also be used to optimise resource use – such as water and fertiliser – and detect early signs of disease or pest infestation, in this way minimising crop losses and enhancing yields (Liakos et al., 2018; Resce-Vaquero-Piñeiro, 2022).

Blockchain technology, instead, emerges as a complementary force within GI systems: by creating distributed and immutable ledgers, blockchain, coupled with AI, can track products “from farm to fork” in light of the related European strategy; such a meticulous tracking system strengthens the same integrity of the GI designation by providing consumers with irrefutable proof of a product's origin and production methods. It should also be noted that – in addition to the traceability mentioned above – blockchain's decentralised nature could enhance collaboration among stakeholders in the GI supply chain; in fact, it could facilitate secure data sharing and streamline administrative processes, ultimately improving efficiency and reducing costs for producers (Kamilaris A., Fonts A. and Prenafeta-Boldó F.X., 2019).

From another point of view, it must be said that, traditionally, evaluating the sensory qualities that distinguish GI products has always relied on human expertise; notwithstanding, AI is emerging as a valuable tool for objectively analysing these unique characteristics. Especially in the domain of beverages – such as coffee, cocoa and tea – AI-powered sensory analysis can dissect the chemical profiles associated with taste and aroma, generating verifiable data that supports the nuanced characterisation expected from GI products, a crucial factor in satisfying consumer preferences. Therefore, by providing a more objective assessment alongside human expertise, AI can enhance consistency and accuracy in evaluating the sensory qualities that define GI products (Bagnulo E., Strocchi G., Bicchi C. and Liberto E., 2024).

Finally, AI-powered image analysis – especially through neural networks – is increasingly applied in quality control; e.g., the morphology of starch granules can be automatically analysed to verify the type of flour in a protected GI bread, ensuring as a result, authenticity and adherence to traditional methods (Fdez-Vidal et al., 2024). The integration of AI into various facets of the GI system – as just described – demonstrates all its far-reaching transformative potential; key areas, such as predictive modelling, supply chain traceability, sensory evaluation and quality control, stand – as above outlined – to benefit immensely from AI-driven solutions by optimising production processes, safeguarding product authenticity and combating

fraudulent practices, AI reinforces consumer trust, strengthening the reputation and economic value of GI products. As a result, even higher levels of accuracy, transparency, and efficiency can be expected in the management of GIs, resulting in their long-term sustainability and perpetuating the unique characteristics and heritage that underpin them. In other words, while there are implementation issues and the need for careful ethical considerations, the future of GIs appears to be inextricably linked to the intelligent application of AI technologies. Such AI-driven advancements in GI systems directly enhance consumer confidence and strengthen the perceived value of GI products; naturally, consumers are increasingly willing to pay premiums for assured authenticity and quality.

Nevertheless, responsible AI development must prioritise transparency, address potential biases and ensure robust data privacy measures: this is essential for maintaining trust and facilitating secure collaboration within the GI value chain. Therefore, far from just a tool, AI is becoming deeply integrated into the fabric of GI systems. At the same time, current research promises even greater innovation, such as AI for risk assessment, streamlining regulatory processes, and directly educating consumers about the value of GIs. Through careful implementation and ethical development, AI has the potential to unlock the full power of GIs; their role as champions of sustainable practices, protectors of tradition and guarantors of exceptional products is poised to be significantly strengthened.

### **Integrating sustainability and artificial intelligence for stronger geographical indication systems**

GIs offer – as anticipated – a powerful framework for promoting sustainable agriculture and preserving the invaluable traditional knowledge embedded within communities; notwithstanding, to truly and fully realise their potential as drivers of positive change, sustainability considerations must be woven into the very fabric of GI regulations within the EU legal system: this means expanding beyond a narrow emphasis on origin and embracing a holistic approach.

As a result, sustainability metrics need to understand GI products' environmental, social, and economic impacts throughout their lifecycle, from how raw materials are purchased to how they are produced, processed, transported, and ultimately consumed. Therefore, the life cycle perspective is essential to align with the EU's climate objectives and support truly responsible practices. Furthermore, harnessing the power of AI requires a commitment to responsible and ethical development; in this sense, policy initiatives should actively incentivise the creation of AI solutions tailored to the unique needs of GI systems, fostering, in this way, innovation that safeguards product authenticity and enhances transparency. In this regard, secure and reliable data-sharing platforms within supply chains will support these efforts.

Finally, the role of consumers must not be neglected, considering that a wide-ranging consumer awareness campaign is essential to building confidence, educating consumers about the multifaceted value of GIs and enabling them to make informed choices, precisely in support of a sustainable future. By integrating all such elements – i.e. sustainability, AI and consumer awareness – it is certainly possible to shape a future in which GIs become powerful drivers, in parallel, of positive environmental, social and economic transformation, safeguarding traditional practices and ensuring the long-lasting of the unique products they represent.

### **Conclusion**

The present paper has explored the intricate connection between European Union law on GIs, the multifaceted concept of sustainability and the disruptive potential of AI. Key findings underscore the inherent sustainability aspects within the existing GI legal framework but, at the



same time, also highlight the immense potential to broaden the scope of these regulations. In this regard, the current emphasis is primarily focused on the origin of products; embracing environmental, social and economic metrics throughout the entire product lifecycle, instead, can further enhance the GI system's ability to drive positive change.

In addition, the untapped capabilities of AI can revolutionise numerous dimensions of GIs, from precision agriculture and supply chain transparency to advanced sensory analysis and quality control, as analysed; this integration would significantly strengthen authenticity and consumer trust. Accordingly, fully realising the benefits of GIs and AI requires a fundamental shift in the overall approach: prioritising a more inclusive vision of sustainability within regulations alongside the responsible development of AI solutions explicitly tailored for verifying and protecting GIs and policy initiatives aimed at offering incentives for such ethical innovation and promoting robust data-sharing platforms within supply chains.

Finally, the power of consumer choice must be harnessed because a comprehensive awareness campaign is vital to educating people on the full value of GIs and empowering them to support sustainable practices in their purchasing decisions.

Therefore, by weaving together sustainability, AI, and consumer awareness, GIs can evolve beyond mere labels, potentially becoming powerful catalysts for positive transformation, safeguarding environmental integrity, preserving the wisdom of traditional practices and ensuring the longevity of the exceptional products they represent.

Unleashing the full potential of AI within GI systems necessitates, naturally, a strong focus on future policy and research directions: policymakers can play a pivotal role by fostering a regulatory environment that encourages the development of AI solutions specifically designed for GI applications; financial incentives and streamlined approval processes for ethical AI could significantly accelerate innovation; research efforts should prioritise the creation of standardised AI models for GI verification across diverse product categories.

In addition, exploring the potential of AI for risk assessment and fraud detection throughout the supply chain presents a compelling avenue for future investigation: the ability of AI to analyse vast datasets and identify patterns invisible to the human eye offers, in fact, a powerful tool for combating counterfeiting and protecting the integrity of GIs.

In this scenario, ethical considerations must remain fundamental as AI integration progresses; accordingly, researchers and developers must be aware of algorithms' potential biases and ensure transparency in AI decision-making. Among other things, robust data security measures are essential to safeguarding sensitive business information within complex IG ecosystems.

Precisely by tracing a path that prioritises the development of responsible AI along with a holistic understanding of sustainability, policymakers and researchers have the opportunity to unlock a future in which GIs flourish; in fact – as illustrated – AI-enhanced GI systems can become a cornerstone of a robust and sustainable food system that celebrates tradition, promotes environmental responsibility and empowers consumers to make informed choices for the benefit of the planet.

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