

Who speaks for sustainable wine?

Definitional struggles and translation processes across six producing countries

Quem define a sustentabilidade na vitivinicultura?

Processos de tradução e de construção de significado em seis países

André Carlos Cau dos Santos

CEPAN/UFRGS Porto Alegre (RS) Brazil

Embrapa Uva e Vinho, Bento Gonçalves (RS) Brazil

Marcelo Kratz Mendes

PPGA/UFRGS. Porto Alegre (RS) Brazil

Olga Cam

University of Sheffield, Sheffield, United Kingdom

Juliana Matos de Meira

University of Sheffield, Sheffield, United Kingdom

Aurora Carneiro Zen

PPGA/UFRGS, Porto Alegre (RS) Brazil

GT 04: Environment, agroecology, sustainability and climate change

Resumo: Este estudo examina como a sustentabilidade é construída e operacionalizada em clusters vitivinícolas no Reino Unido, França, Itália, Espanha, África do Sul e Brasil, utilizando a Teoria Ator-Rede (ANT) como lente analítica. Ao invés de tratar a sustentabilidade como um objetivo normativo fixo, o artigo a conceptualiza como uma realização sociomaterial situada, contestada e contingente, emergente de redes heterogêneas de actantes humanos e não humanos. Empiricamente, a análise baseia-se em 28 entrevistas semiestruturadas realizadas entre junho de 2024 e setembro de 2025 com proprietários de vinícolas, líderes de cooperativas, consultores, investigadores e representantes de associações profissionais. A análise temática apoiada pelo NVivo, seguida de um diálogo abduutivo com conceitos da ANT, é utilizada para identificar como a sustentabilidade é enquadrada, quais dispositivos são mobilizados e como as configurações sociomateriais diferem entre clusters. Os resultados mostram trajetórias altamente diferenciadas: no Reino Unido, a sustentabilidade é impulsionada por métricas e certificações; em França, é ancorada em cultivares resistentes e dispositivos legais; em Itália, em tecnologias de adegas e incentivos fiscais; na África do Sul, em responsabilidade social e regimes de certificação; em Espanha, em eco-certificações e enoturismo; e no Brasil (Serra Gaúcha), em viabilidade económica e governança técnica. O artigo contribui mostrando como configurações distintas produzem versões múltiplas e parcialmente conectadas de sustentabilidade.

Palavras-chave: teoria ator-rede, sustentabilidade sociomaterial, clusters vitivinícolas, processos de tradução, análise comparativa multi-país.

Abstract: The paper examines how “sustainability” is constructed and enacted in wine clusters in the United Kingdom, France, Italy, Spain, South Africa and Brazil, using Actor-Network Theory (ANT) as its analytical framework. Rather than treating sustainability as a fixed normative goal, it conceptualises it as a situated, contested and socio-material accomplishment emerging from heterogeneous networks of human and non-human actants. Theoretically, the study brings together wine-sustainability and cluster literatures with ANT’s material-semiotic lens. Wine regions are approached not as pre-given territorial containers but as actor-networks whose coherence is achieved through translation processes (problematisation, interessement, enrolment and mobilisation) through which particular versions of “sustainable wine” are assembled and stabilised. Empirically, the analysis draws on 28 semi-structured interviews conducted between June 2024 and September 2025 with winery owners, cooperative leaders, consultants, researchers and association representatives. Thematic analysis supported by NVivo, followed by an abductive dialogue with ANT concepts, is used to identify how sustainability is framed, which devices are mobilised and how socio-material configurations differ across clusters. The findings show highly differentiated trajectories. In the UK, sustainability is metrics-and certification-driven, but unevenly adopted. In France, it is anchored in resistant cultivars, disease pressure and dense legal-administrative dispositifs. Italian cases foreground cellar technologies, efficiency, and fiscal incentives; South African networks combine resource stress with social responsibility and certification schemes; Spanish cases hinge on eco-certifications, cooperative mediation, enotourism, and carbon accounting; and Brazilian (Serra Gaúcha) actors emphasise economic viability, technical governance, and everyday vineyard and cellar practices. The paper contributes to ANT-informed sustainability research by showing how distinct actor-network configurations produce multiple, partially connected versions of

sustainability, shaped by non-human actants and definitional struggles, rather than by universal frameworks or linear transition paths.

Keywords: Actor-Network Theory (ANT); socio-material sustainability; wine clusters; translation processes; multi-country comparative analysis.

1. Introduction

Sustainability in the wine sector is neither a predefined objective nor a neutral technical challenge. Instead, it is a complex, evolving and deeply contested construct whose meaning varies across contexts, actors, and time (Santini; Cavicchi; Casini, 2013; Szolnoki, 2013; Flores, 2018). Scholars have emphasised that sustainability is negotiated within and between wine-producing regions, shaped by shifting socio-cultural, economic and ecological priorities rather than fixed benchmarks (Flores, 2018; Forbes; De Silva; Gilinsky, 2020; Gabzdylova; Raffensperger; Castka, 2009). This complexity is amplified by the wine sector's embeddedness in place-based heritage, its dependence on natural conditions, and its exposure to global market forces (Anderson; Pinilla, 2018). As climate change intensifies disease pressures, affects water availability and alters growing conditions, and as regulatory frameworks and consumer values evolve, wine clusters worldwide are navigating heterogeneous pathways toward environmentally sound, socially equitable and economically viable production models, as reflected in the evolving OIV sustainability resolutions (OIV, 2004, 2016, 2020) and in sector-level empirical research (Annunziata et al., 2018). In this context, sustainability appears less as a stable target and more as an evolving field of contention and compromise, continually redefined as new ecological risks, regulatory instruments and market expectations emerge.

Actor-Network Theory (ANT) provides an analytical lens suited to examining this diversity. Building on the foundational contributions of Callon (1984), Law (2008) and Latour (2007), ANT rejects conceptualisations of sustainability as an external normative standard or stable institutional mandate. It reconceptualises the social as a circulation of associations (Latour, 1999, 2007) in which human and non-human entities (vines, pathogens, pruning systems, infrastructures, documents, digital tools, climatic events) participate symmetrically in shaping outcomes. Latour (1999) characterises ANT less as a finished theory than as a way of “re-calling” and following associations, while Law (2008) describes it as a family of material-semiotic sensibilities that treat entities as effects of the relations in which they are enacted. From this perspective, sustainability is not a fixed state but an emergent effect of heterogeneous networks composed of agronomic practices, technologies, legal classifications, environmental pressures, market logics, and territorial identities.

ANT also directs attention to the definitional struggles that shape sustainability. According to Ählström & Egels-Zandén (2008), concepts such as responsibility and

sustainability stabilise only through struggles over meaning, legitimacy, and representation. This dynamic is visible across all six countries examined in this study, where definitional conflicts over sustainability are not peripheral but constitutive of the concept itself.

Furthermore, ANT highlights that stakeholders emerge through networks rather than existing as pre-formed categories (Marcon Nora; Alberton; Ayala, 2023). This insight is particularly relevant for wine clusters, which are dynamic institutional environments where knowledge circulates, identities are negotiated and governance structures intersect (Becattini, 2002; Giuliani, 2007, 2013; Zen et al., 2022). Law (1999, 2008) invites such arrangements to be read as effects of intersecting networks, where different versions of “sustainable wine” may coexist. Taken together, this study traces the translations, devices and heterogeneous actants through which sustainability is defined in six wine clusters, treating it as a set of multiple, partially connected realities enacted through distinct actor-networks (Latour, 1999; Law, 2008).

Building on this perspective and on a comparative analysis of six wine clusters (United Kingdom, France, Italy, Spain, South Africa and Brazil), this paper argues that sustainability in wine clusters is not a fixed universal standard but the contingent outcome of specific socio-material configurations of human and non-human actants. Recognising this plurality, it contends, is crucial for designing realistic sustainability standards and policies that align with the actual constraints, devices and actor-networks that shape vineyard and winery practices.

2. Literature review

The sustainability literature in wine studies has made clear that the concept resists neat definition. Territorial programmes such as Sustainable Winegrowing New Zealand, Lodi Rules and Integrated Production of Wine illustrate how sustainability adapts to local institutional environments and resource conditions (Gabzdylova; Raffensperger; Castka, 2009; Szolnoki, 2013). While some producers equate sustainability with organic or biodynamic certification, others emphasise broader practices involving innovation, governance or socio-economic resilience (Annunziata et al., 2018; Szolnoki, 2013). This body of work, however, tends to treat the underlying category “sustainability” as given rather than examining how it is practically assembled and held together across different settings.

Wine regions have traditionally been analysed as clusters, understood as territorially embedded configurations where firms, institutions, technologies and cultural identities co-evolve (Becattini, 2002; Giuliani, 2007, 2013; Zen et al., 2022). Because clusters combine formal institutions with informal conventions and territorial narratives, they provide contexts in which sustainability practices are negotiated or contested. However, much of this literature still treats territories as relatively bounded contexts, with less attention to how non-human

elements, such as infrastructures, diseases or technical devices, participate in shaping what a cluster is and what it can become.

Actor-Network Theory (ANT) provides a framework for re-examining both sustainability and clusters from a socio-material standpoint. Rather than assuming that “sustainable wine” is a pre-existing object subsequently adopted by firms or regions, ANT invites analysis of how specific versions of sustainability are generated, maintained and sometimes undone in practice through processes of translation (Callon, 1984; Latour, 1999, 2007; Law, 1999, 2008).

From an ANT standpoint, clusters are not pre-given territorial containers but historically situated actor-networks whose coherence is an achievement rather than a starting point. Law (1999) shows that networks generate their own topologies, and Law (2008) argues that such arrangements are often multiple and only partially connected. In wine regions, this suggests that cluster boundaries, governance structures and sustainability narratives are outcomes of socio-material work rather than static structural properties.

ANT also illuminates the political dimensions of sustainability. As Ählström and Egels-Zandén (2008) show, concepts such as responsibility or sustainability are stabilised through struggles over meaning and legitimacy. Who can speak for sustainability, which indicators are recognised, and how practices are framed as “responsible” or “unsustainable” are outcomes of translation processes that enrol specific devices, narratives and actors (Latour, 1999; Law, 1999).

Furthermore, ANT challenges the assumption that stakeholders are pre-defined categories; instead, they are constituted through socio-material configurations of artefacts, policies and practices (Marcon Nora; Alberton; Ayala, 2023). In wine clusters, certification schemes, varietal catalogues, disease pressures and regulatory instruments do not merely affect pre-existing stakeholders; they help define which actors matter, how they are positioned and whose interpretations of sustainability become influential.

Taken together, the literature shows that territorial configurations, socio-material dynamics and negotiated meanings shape sustainability in the wine sector, but tends to treat key categories, such as sustainability, stakeholders or clusters, as analytically given. ANT complements this work by focusing on how these categories themselves are assembled, contested and materially grounded within cluster environments.

3. Methodology

This study employs a qualitative, multi-country research design to examine how sustainability is constructed and operationalised within wine clusters. Data were generated

through semi-structured interviews with key actors in the vitivinicultural sector, including winery owners, cooperative directors, sustainability consultants, public researchers, and representatives of professional associations. Between June 2024 and September 2025, a total of 28 interviews were conducted across six countries: Brazil, Italy, Spain, the United Kingdom, France and South Africa. Interviews lasted between 40 and 90 minutes and were carried out either in person or via video conferencing, depending on participants' availability and geographic constraints.

All interviews were audio-recorded with informed consent and transcribed verbatim. The analysis followed the principles of thematic analysis (Braun; Clarke, 2006), enabling the identification of patterns emerging inductively from the empirical material. Initial descriptive and interpretive codes were generated using NVivo 14 (Lumivero, 2023), focusing on how actors define sustainability, the socio-material devices they employ, and the relationships they consider central in shaping sustainability practices.

A second, abductive phase of analysis refined these themes by engaging with key concepts from Actor-Network Theory. In particular, the analytical attention turned to Callon's (1984) four moments of translation, namely problematisation, interessement, enrolment and mobilisation, to trace how actors define sustainability challenges, negotiate alignments, distribute roles, and attempt to stabilise particular interpretations within each cluster. This approach foregrounded the role of heterogeneous mediators, including certification schemes, varietal catalogues, digital reporting tools, phytosanitary regulations, resistant grape varieties, and infrastructural constraints.

The combination of inductive and abductive analysis enabled a systematic comparison of sustainability configurations across the six countries, illuminating both convergences and divergences in actor-network arrangements. The paper reports cross-country patterns emerging from this dataset. Further analytical refinement through additional material and triangulation could deepen the understanding of socio-material dynamics within and across wine clusters.

This study was financed by the University of Sheffield (X/008802-16-6) and CAPES, Brazil (Finance Code 001). The authors used artificial intelligence tools (Claude, developed by Anthropic; ChatGPT, developed by OpenAI) to assist with narrative flow and grammar revision. All analytical content, interpretations and arguments remain the sole responsibility of the authors.

4. Results and discussion

The comparative analysis of interviews conducted across the six countries reveals distinct socio-material configurations that shape how sustainability is constructed and enacted

within wine clusters. Guided by Actor-Network Theory, the analysis focuses on translation processes, namely problematisation, interessement, enrolment and mobilisation, as well as the mediating devices, constraints, and relational patterns that stabilise or destabilise sustainability trajectories across territories. The analysis highlights variations in institutional configurations, strategic priorities and networked relationships shaping sustainability practices across the six clusters. Figure 1 presents a summary of the main actors and sustainability focuses identified in each cluster.

Figure 1. Summary of key actors and sustainability focuses in wine clusters

UNITED KINGDOM Key actors: WineGB/SWGB, medium-large wineries, vineyard managers, universities, local partners Main sustainability focus: Metrics-driven sustainability: measurement, monitoring, certification and digital tools for efficiency
FRANCE Key actors: IFV, INRAE, UMT Génovigne, CTPS, nurseries, interprofessions, growers Main sustainability focus: Environmental reconfiguration, resistant cultivars, pesticide reduction, preserving yields and quality
ITALY Key actors: Process-technology firms, medium/large wineries, universities, public incentive agencies, industrial clients Main sustainability focus: Cellular process modernisation: energy and water savings, safer labour and ROI-oriented upgrades
SOUTH AFRICA Key actors: Farms and wineries, workers, consultants/Vinpro, universities, IPW and ethical schemes, retailers Main sustainability focus: economic survival, social responsibility, water scarcity and energy constraints
SPAIN Key actors: Export-oriented estate winery, DOs, cooperative federations, municipalities Main sustainability focus: Eco certification, carbon accounting, enotourism under drought and land-use change
BRAZIL Key actors: Wineries, grape-growing families, technical assistance services, research institutes, enotourism actors Main sustainability focus: Economic viability, technical governance, circular use, integrated production amid climate shocks

Source: developed by the authors (2025).

4.1 United Kingdom: Metrics, Institutional Anchoring, and Partial Mobilisation

In the United Kingdom, sustainability emerges in these case studies as a largely metrics-driven and institutionally coordinated actor-network, anchored in the central role of WineGB and, more specifically, the Sustainable Wine of Great Britain (SWGB) scheme (Latour, 2007; Law, 2008). These institutions are described as functioning as obligatory passage points that define what counts as sustainable practice, how it should be measured, and how producers must demonstrate compliance (Callon, 1984). Interviewees consistently emphasised that, in their experience, sustainability initiatives did not originate from external regulation or policy pressure but from internal concerns with vineyard longevity, operational efficiency, and long-term economic viability. As one producer explained, sustainability was fundamentally about “keeping the vineyard healthy and productive... hopefully another 27 years,” linking environmental responsibility to durable asset management rather than normative discourse.

The sustainability network is held together through a dense assemblage of measurement and monitoring devices operating as interessement mechanisms (Callon, 1984; Latour, 1999; Law, 2008). Vineyards employ quantitative indicators (soil health tests, organic matter

analyses, earthworm counts, canopy metrics, toxicity index calculations) that function simultaneously as diagnostic tools and alignment devices, translating sustainability into something quantifiable and actionable.

Measurement devices do not merely record sustainability; they participate in producing it. As one grower noted, toxicity indexes revealed that “copper is incredibly toxic on all counts,” challenging assumptions among both organic and conventional actors. Digitalisation reinforces this network: digital diaries, QR codes and remote-sensing collaborations with universities integrate climate forecasting and disease prediction into daily management.

Enrolment occurs through structured institutional coordination, with WineGB orchestrating standards and expectations (Callon, 1984; Latour, 2007). The SWGB scheme is described as “a process of collaboration” built over four years. Knowledge circulation through working groups, newsletters and academic partnerships extends the network into education, training and community engagement.

Despite this institutional scaffolding, enrolment across the UK, as reported in the interviews, appears uneven. Multiple interviewees highlighted that only around 20% of WineGB members were participating in the sustainability scheme. Small and micro-wineries are depicted as often opting out due to administrative burden, perceived lack of direct benefit, limited staff capacity, or philosophical disagreements with the formalisation of sustainability.

Producers described sentiments such as: “Why should I do it? I’m doing sustainable things anyway; I don’t need to fill out paperwork.”

This suggests a fundamental definitional struggle, a hallmark of ANT and consistent with Åhlström and Egels-Zandén’s argument that sustainability stabilises only through negotiation and contestation (Åhlström; Egels-Zandén, 2008; Latour, 1999; Law, 1999). In the UK cases, this struggle appears to pit data-driven institutional models against the experiential, tacit knowledge of small-scale producers who view sustainability as embedded in their everyday care for the land.

In these UK cases, sustainability is described as being deeply mediated by non-human actants. Non-human actants such as rainfall patterns intensifying downy mildew, frost events, glass bottle supply chains (the single largest environmental impact component, yet with no domestic sparkling-wine bottle manufacturing) and heritage buildings limiting energy retrofits are described as actively shaping sustainability pathways rather than serving as passive context.

In the UK cases, mobilisation appears strongly driven by certifications that function as identity devices. Interviewees perceive B Corp accreditation as a global marker of ethical practice, helping wineries recruit staff, appeal to younger consumers, and align with

international markets. SWGB “Gold” certification is presented as tangible proof of sustainable practice for trade buyers, restaurants, and export destinations such as Norway. These certifications operate as spokespersons that articulate and represent the network to external audiences.

Yet, from the respondents’ perspective, mobilisation seems incomplete. The sector is portrayed as lacking coherent public policy support, with one respondent noting: “There is no public policy... everything was self-funded or volunteer-built.” Benchmarking systems are described as underdeveloped, and the gap between certified and non-certified producers is perceived as risking fragmentation of the actor-network. This partial mobilisation can be read, through an ANT lens, as illustrating the fragility and incompleteness of alignments, and the ongoing work required to stabilise sustainability as a socio-material achievement in clustered agri-food systems (Law, 2008; Zen et al., 2022).

4.2 France: Environmental Reconfiguration, Varietal Controversies, and Dense Institutional Governance

In France, in the cases examined here, sustainability is translated overwhelmingly through a framework of environmental reconfiguration in viticulture, jointly constructed by state agencies, technical institutes, interprofessions, nurseries, and growers (Callon, 1984; Latour, 2007; Law, 2008). Across interviews, the primary sustainability challenge is framed not as a broad moral imperative, but as a practical and institutional reorganisation of viticulture oriented toward sharp reductions in pesticide use, especially copper and synthetic fungicides, while maintaining yields, quality, and Appellation integrity. Public research bodies, most notably IFV, INRAE and UMT Génovigne, are portrayed as functioning as obligatory passage points, defining what sustainability should mean, which techniques are legitimate, and how this environmental transition is to be operationalised (Callon, 1984; Latour, 1999, 2007). Their missions, state funding structures, varietal evaluation mandates, and technical certifications are described as shaping the space of possible futures, stabilising some pathways while foreclosing others (Law, 1999, 2008).

Unlike the UK, where sustainability in the interviews is mainly anchored in measurement and certification, the French configuration is presented as anchored in varietal innovation, disease pressure, and legal dispositifs. Sustainability thus becomes, in these accounts, a matter of reorganising the biological foundations of viticulture, its vines, diseases and agronomic cycles, through new material assemblages capable of meeting institutional and climatic demands.

Interessement mechanisms in France, as described by interviewees, are strong and often encoded in legal and administrative inscriptions that determine what kinds of viticulture can exist (Callon, 1984; Latour, 1999; Law, 1999). Resistant varieties (Souvignier Gris, Floréal, Vidoc, Artaban, among others) operate as central interessement devices binding growers, nurseries, researchers, and state bodies into aligned but contested sustainability pathways. These cultivars are reported to materially reduce the need for treatments from around 15–20 annual sprayings to as few as five, making the envisaged environmental transition technically feasible in the situations discussed. They enrol growers by offering practical solutions to labour constraints, disease intensity, and the escalating costs and scrutiny associated with phytosanitary inputs.

Public policy instruments are depicted as reinforcing these devices. The Ecophyto plan, which targets a 50% reduction in pesticide use, creates a shared institutional horizon and aligns actors around quantifiable environmental objectives. In parallel, the five-year accreditation cycles for technical institutes impose constraints and expectations that shape varietal trials, disease experimentation, and the articulation of environmental and agronomic priorities.

Legal-administrative instruments, including EU and French variety catalogues, classification rules, phytosanitary passports and subsidy eligibility criteria, act, in the interview narratives, as particularly powerful interessement devices in the French sustainability network. These inscriptions define which varieties legally exist, how they can circulate, and which technologies or plant materials qualify for state support. Interviewees describe how these legal dispositifs tend to favour nationally bred resistant varieties while limiting or slowing the authorisation of foreign resistant grapes, creating perceived tensions between national protection and scientific or commercial openness. These devices are thus seen as constraining innovation as much as enabling it, stabilising certain futures while blocking others (Law, 1999, 2008).

Despite strong institutional governance, enrolment in France, as portrayed by the interviews, is not purely top-down; growers and nurseries emerge as proactive, experimental, and anticipatory actors. Multiple estates are said to conduct independent varietal trials, test disease-resistance performance, and adjust vineyard architectures to adapt to climatic and phytosanitary pressures, sometimes ahead of formal regulatory authorisations. For these actors, sustainability appears not as an abstract principle but as a set of urgent, practical concerns: reducing labour burdens, protecting worker health, mitigating extreme weather and disease shocks, and securing stable yields.

Private nurseries enrol growers into the resistant-variety pathway through market interactions and technical advice, sometimes diverging from public breeding institutions' timelines. Technical institutes simultaneously enrol and are enrolled, while interprofessions translate directives into territorially coherent narratives. The result is a plural and negotiated enrolment process (Callon, 1984; Latour, 2007; Law, 2008).

Non-human actants shape the French network decisively. Pathogens (flavescence dorée, downy mildew, *Xylella fastidiosa*, Pierce's disease) exert intense pressure on breeding priorities and phytosanitary regulations. Climate stressors act as forcing mechanisms, with interviewees describing work with *Vitis arizonica* genetics to prepare for future scenarios. Climate change is not a mere backdrop but a co-actor continuously modifying the network (Latour, 2007; Law, 2008).

Mobilisation in France, as described by interviewees, is intense and often contested. Public research institutes mobilise discourses of scientific legitimacy, national varietal identity, and environmental responsibility to justify their centrality in varietal evaluation and in steering environmental change in viticulture. They claim to speak for the "general interest" and for the long-term future of French viticulture, acting as spokespersons for particular network configurations (Callon, 1984; Latour, 1999).

CTPS (the state classification committee) mobilises narratives of quality protection and heritage preservation to legitimise restrictive varietal rules. Meanwhile, private nurseries and PIWI France mobilise alternative narratives of fairness, scientific pluralism and responsiveness to on-farm experience, contesting what they describe as conservative features of the classification system that slow innovation and restrict the circulation of foreign resistant varieties.

4.3 Italy: Process Technologies, Policy Incentives, and Negotiated Efficiency

In Italy, in the cases examined here, sustainability is translated primarily through the optimisation of cellar processes, resource savings, and improved working conditions, rather than through vineyard-level ecological interventions. Across interviews with the technology provider and wineries, the central problematisation is: how to reconfigure winemaking operations to be faster, less energy- and water-intensive, and safer for workers, while preserving wine quality and maintaining viable economic margins. This resonates with broader discussions of sustainability as embedded in operational practices and economic resilience rather than a single normative definition (Annunziata et al., 2018; Flores, 2018; Santini; Cavicchi; Casini, 2013; Szolnoki, 2013).

For the technology firm, sustainability is framed as encompassing energy and water savings, working conditions, ethical commitments and organisational efficiency. Their equipment is designed so that sustainable practice is embedded in the machinery rather than added as an external requirement.

Public policy is described as amplifying this problematisation. European grants and Italian Industry 4.0 and 5.0 schemes transform sustainability into a modernisation project: to access tax credits and funding, wineries must invest in interconnectable, energy-saving equipment that fits specific technical criteria. Under Industry 4.0, machines must be connectable to SCADA systems and able to exchange data with human operators; Industry 5.0 focuses more directly on demonstrable energy savings. Tax benefits of around 30–40% and grants covering 40–50% of investment costs make certain forms of “sustainable modernisation” economically feasible, especially for larger producers. These instruments can be read as policy inscriptions that align actors around particular socio-technical pathways (Latour, 1999; Law, 1999, 2008).

Unlike France, where sustainability in the interviews is anchored in varietal change and disease control, the Italian network appears anchored in cellar technologies, fiscal incentives, and return-on-investment logics. Sustainability is enacted by reorganising the technological and economic infrastructure of production, through assemblages of machines, software, tax rules, energy bills and certification processes rather than through changes in vineyard genetics or appellation rules.

Interessement mechanisms in Italy are strongly material and policy-driven (Callon, 1984; Latour, 1999; Law, 2008). Industry 4.0 and 5.0 incentives operate as powerful interessement devices: to qualify, equipment must be interconnectable and energy-efficient, effectively steering which technologies will be developed and adopted (Latour, 1999; Law, 1999, 2008). Industrial clients increasingly request technical data and refer to standards such as ISO 14000, encouraging firms to treat sustainability as measurable and auditable.

Enrolment in Italy is orchestrated through collaborations between technology firms, universities, and wineries, but takes differentiated forms across the sector. The technology provider positions itself as a mediator that translates policy instruments, OIV guidelines, and scientific knowledge into practical cellar solutions. It collaborates with universities in Verona, Padua, Udine and Milan, as well as with international partners, to test new technologies and evaluate process effects.

Wineries are enrolled unevenly. Large industrial producers systematically analyse technologies in terms of return on investment, including potential communication gains from

demonstrating energy or water savings. Medium-sized wineries also engage with these logics, but somewhat more selectively. Small wineries tend to be cautious: some high-end producers adopt specific technologies or certifications for image and marketing purposes, but many others give less priority to resource-saving equipment, especially where water and energy are relatively cheap and investment budgets tight. This plural pattern of enrolment reflects how different positions within the cluster structure access and respond to the same devices (Becattini, 2002; Giuliani, 2007, 2013; Zen et al., 2022).

The Italian sustainability network is shaped by non-human actants. Energy demand for cooling, pumping and stabilisation acts as a constant pressure, pushing wineries toward continuous processes and energy-efficient alternatives. Water plays a similar but weaker role: in Italy, where water is reported as cheaper, saving technologies are less urgent for small wineries.

Mobilisation in Italy revolves around defining what a “sustainable” and “modern” wine sector should look like. Technology firms present themselves as spokespersons for the future of winemaking; the state and the EU mobilise through fiscal incentives that privilege digitalisation and energy-efficient processes; and industrial clients propagate specific understandings of sustainability through purchasing power and audit requirements. Some small wineries resist, enacting alternative versions centred on certification, photovoltaic investment and enotourism.

4.4 South Africa: Social Responsibility, Certification Regimes, and Resource-Stressed Sustainability

In South Africa, in the cases examined here, sustainability appears to be translated through a strongly “three-legged” problematisation that combines economic survival, social responsibility toward workers and communities, and environmental stewardship of land and water (Flores, 2018; Gabzdylova; Raffensperger; Castka, 2009; Szolnoki, 2013). Interviewees repeatedly frame sustainability as a question of how to “stay on the farm” economically while “looking after our people” and “leaving the soil better than we found it”. Rather than a purely ecological or purely market-driven issue, sustainability is described as a practical reconfiguration of farming and cellar operations under conditions of water scarcity, rising energy costs, historical inequality, and highly competitive export markets (Annunziata et al., 2018; Forbes; De Silva; Gilinsky, 2020).

This problematisation is not presented as defined by a single state body, but as emerging from the interaction of farms, wineries, technology choices, local audit schemes, export buyers (especially in Northern Europe), and, to a lesser extent, public incentives. Industry-driven

schemes such as the Integrated Production of Wine (IPW) system, ethical and Fair Trade-type labels, and biodiversity-oriented programmes appear as de facto obligatory passage points: to sell into certain markets, be recognised as “responsible”, or secure tenders, actors in these cases must pass through these certification and audit devices, which function as obligatory passage points in Callon’s (1984) sense.

Unlike France, where sustainability in the interviews is anchored in varietal innovation and disease-control policies, the South African configuration described here seems anchored in social schemes, certification regimes, and resource constraints, especially water and electricity. Sustainability becomes a matter of reassembling vineyards, cellars, housing, transport, audits, and monitoring devices into configurations that can deliver social care, environmental protection, and economic viability simultaneously.

Interessement mechanisms in South Africa, as portrayed by the interviewees, revolve around concrete programmes, standards, and technologies that “hook” actors into particular sustainability trajectories (Callon, 1984; Latour, 1999; Law, 2008). On the environmental side, IPW functions as a central device. It combines vineyard and cellar audits, points-based scoring, and periodic inspections, with a minimum score required to obtain the seal. In the accounts analysed, this device stabilises certain practices, such as reduced chemical use, proper waste management and monitored water and energy consumption, by tying them to label authorisation and, indirectly, market access. A second scheme, focused on biodiversity and natural vegetation, is reported to require producers to maintain significant areas of natural veld, remove invasive species, and create ecological corridors, effectively enrolling non-productive land into the sustainability network.

Ethical trade and Fair Trade-type standards (including VITA and related schemes) play a parallel role on the social and labour fronts. Interviewees explain that Nordic and other export markets now accept a list of “ethical standards” and specify them in tenders; access to those tenders thus depends on being certified under one of these labels. These schemes require documented labour conditions, community projects, and governance structures, transforming social practices into auditable inscriptions.

In the cellar and vineyard, specific technologies also act as interessement devices: moisture probes connected to satellite interfaces, on-farm weather stations, winter cover crops rolled down as mulch, and the introduction of natural predators against mealybug (released in tubes rather than insecticide) all reshape farming practices toward lower-input futures.

On the social side, housing schemes, savings funds, and educational support packages function as powerful interessement devices. Taken together, certifications, technologies, and

social schemes constitute a dense web of interessement devices that, in these cases, connect farms, wineries, workers, consultants, retailers, and auditors into shared, if contested, notions of “sustainable” practice (Ählström; Egels-Zandén, 2008; Callon, 1984; Latour, 2007; Law, 2008).

Enrolment unfolds through multi-level alliances. Farm owners experiment with organic and regenerative techniques while acknowledging logistical limits. Workers are enrolled through employment, housing and education programmes. Industry consultants (Vinpro and others) translate sustainability goals into concrete vineyard operations. Universities contribute on-farm research, and export buyers in Northern Europe tie distant retail systems into the network through certification requirements (Forbes; De Silva; Gilinsky, 2020; Gabzdylova; Raffensperger; Castka, 2009).

Non-human actants exert decisive influence in the South African sustainability assemblage. Water scarcity, rising electricity tariffs and pest pressures (notably mealybug) shape farming decisions and reconfigure the network.

Mobilisation in South Africa, in these cases, revolves around who can legitimately speak for “real” sustainability in a context where national organic standards do not exist and “regenerative” has become a fashionable but ambiguous term.

The state appears weakly mobilised, with limited and episodic interventions, making these networks more industry- and market-driven than policy-driven (Forbes; De Silva; Gilinsky, 2020; Gabzdylova; Raffensperger; Castka, 2009). Export buyers shape which sustainability narratives gain traction through purchasing power and tender specifications, though strong narratives do not always translate into proportional shifts in demand.

4.5 Spain: Eco-Certification, Cooperative Mediation, and Tourism-Led Sustainability Narratives

In Spain (Alicante/Villena), in the small set of cases examined here, sustainability is problematized through two partially connected networks: a privately owned, export-oriented estate winery and a long-standing cooperative. Both tend to frame sustainability less as an abstract moral principle and more as a way of securing viable production models, territorial identity, and differentiated market positions under conditions of drought, land-use change, and shifting EU rules (OIV, 2016; Santini; Cavicchi; Casini, 2013; Szolnoki, 2013).

For the private winery, sustainability is articulated as one of three core pillars (sustainability, respect for the environment and product quality) embodied in a long trajectory of organic, biodynamic, and vegan certifications pursued since the project’s founding. Interviewees describe the estate as having been conceived ‘desde el principio’ as both a

production site and a visitable winery, with ecological production as the main pillar and other certifications added over time. Commercial motivations (export markets perceived as “años luz” ahead in eco-demand) intersect with the owners’ personal lifestyle, where organic products are central to everyday consumption.

For the cooperative, sustainability revolves around agricultural viability and generational renewal. Growers see traditional, low-input practices as inherently sustainable, while new EU requirements push them to comply with increasingly complex environmental criteria.

In ANT terms, the Denominación de Origen Alicante, the Ruta del Vino de Alicante / Rutas del Vino de España, cooperative federations, and local municipal initiatives can be interpreted as overlapping obligatory passage points through which sustainability projects in these cases must circulate, whether in the form of carbon-footprint calculations, eco-certifications or enotourism programmes (Callon, 1984; Latour, 2007).

In the material examined, interessement in Spain seems to rely heavily on certification schemes, tourism quality systems, and emergent carbon-accounting devices (Callon, 1984; Latour, 1999; Law, 2008).

At the estate, a sequence of certifications (EU organic, Demeter, D-Label) structures the sustainability pathway. Each requires multi-year practice and repeated audits, turning guidelines into material devices that discipline vineyard and cellar work.

For both the estate and the cooperative, the DO Alicante carbon-footprint project functions as a shared device: a centralised initiative where the DO coordinates methodology, calculations, and follow-up plans. Wineries gather data on energy, materials, and processes, while the DO and an external firm translate these into emissions metrics and action plans (installation of solar panels, change of lighting, vehicle renewal, etc.).

Taken together, certifications, tourism quality schemes, carbon metrics, eco-taxes, and digital reporting can be seen as forming a dense set of inscriptions, in Latour’s (1999) sense, that attempt to fix what counts as sustainable practice in this Spanish context.

Enrolment processes in Spain, as reflected in these interviews, are plural and negotiated (Callon, 1984; Latour, 2007; Law, 2008). At the estate, owners, staff and visitors are progressively enrolled through sustainability narratives embedded in vineyard tours, certification labels and local supply chains. For the cooperative, enrolment revolves around hundreds of members and the in-house agricultural engineer, who assists with digital field notebooks and treatment recommendations. Cooperative federations and the DO Alicante enrol co-ops into broader R&D and carbon-footprint initiatives.

Non-human actants play a strong role in the Spanish sustainability networks. At the estate, water self-sufficiency and solar energy were foundational investment decisions, with aesthetic integration prioritised over cost minimisation. For the cooperative, drought is the dominant non-human actor: successive dry years have halved yields, pushing land toward abandonment or conversion to horticulture and solar parks.

In the Spanish cases studied here, mobilisation appears to revolve around who can legitimately speak for sustainability and for the future of the territory, echoing the idea of sustainability as a contested concept shaped by competing narratives and claims (Ählström; Egels-Zandén, 2008; Forbes; De Silva; Gilinsky, 2020; Gabzdylova; Raffensperger; Castka, 2009).

The estate mobilises sustainability as a core brand attribute, leveraging eco-certifications, self-funded heritage restoration and energy self-sufficiency to build a “marca respetuosa.” The cooperative, federations and DO mobilise narratives of territorial rootedness, carbon-footprint coordination and political interlocation with authorities. Tensions persist: farmers increasingly depend on subsidies, EU conditionality sometimes induces compliance-driven behaviour, and traditional crops compete with horticulture and solar parks for land. Consumer mobilisation remains limited beyond the familiar organic label (Forbes; De Silva; Gilinsky, 2020; Szolnoki, 2013).

4.6 Brazil: Economic Viability, Technical Governance, and Everyday Sustainability Work

In Brazil, sustainability is problematised in the interviews above all as keeping winegrowing viable over time. Across the interviews, different wineries and organisations converge on the idea that the economic dimension is often treated as a precondition: if the activity does not generate income and “create wealth”, environmental and social initiatives cannot easily be sustained. Sustainability is therefore framed less as an abstract ideal and more as an ongoing effort to make viticulture livable for families, workers and firms in the face of climate shocks, cost pressures and changing regulations.

Although Brazil is a large and heterogeneous wine-producing country, the interviews analysed here were conducted in a specific regional cluster in the Serra Gaúcha, and the patterns described refer to this context. When the text uses the shorthand “Brazil”, it should be read as “the Brazilian wine actors interviewed in Serra Gaúcha”, consistent with the view of wine regions as territorially embedded clusters with their own institutional and socio-material configurations (Becattini, 2002; Giuliani, 2007; Zen et al., 2022).

From an Actor-Network Theory perspective, these actors appear to share a common problem: how to recombine vines, growers, infrastructures, technical norms and markets so that

wine production remains possible and respectable, while reducing negative impacts. Rather than distinct “models” of sustainability, the interviews reveal a set of overlapping translations anchored in similar devices and practices.

Brazilian wineries mobilise a broadly similar repertoire of interestment devices. Certifications translate expectations into concrete obligations: documented procedures, audits, residue limits and traceability demands (Callon, 1984; Latour, 2007). Technical assistance and *cadernos de campo* serve as central vineyard tools, while process infrastructures (water treatment, solar panels, composting of bagasse and stems) stabilise a narrative linking environmental performance with cost control. Tourism programmes, especially those adapted after recent floods, add another layer of territorial identity (Gabzdylova; Raffensperger; Castka, 2009; Zen et al., 2022).

Grape growers are enrolled via delivery relationships, technical visits and field records, adjusting practices in line with recommendations and residue standards. The return of composted residues to vineyards enacts a material link reinforcing cooperation. Universities and research institutions are drawn into experimental plots and problem-solving projects through negotiated relationships (Callon, 1984; Latour, 2007).

Across the Brazilian interviews, non-human actants seem to have a comparable, cross-cutting presence. Recent floods and episodes of excessive rainfall play a significant role: they damage vineyards, disrupt tourism and expose vulnerabilities in infrastructure and management. Where cover crops were established under vines, interviewees describe reduced erosion and losses, turning these plants into visible co-actors in vineyard resilience.

Regulatory and fiscal artefacts, including certification protocols, residue limits, labour and environmental norms and the ongoing tax reform with a possible selective tax on wine, are experienced as fundamental forces that can accelerate or complicate sustainability trajectories. They sit alongside natural events as important non-human actants in the network (Latour, 1999, 2007).

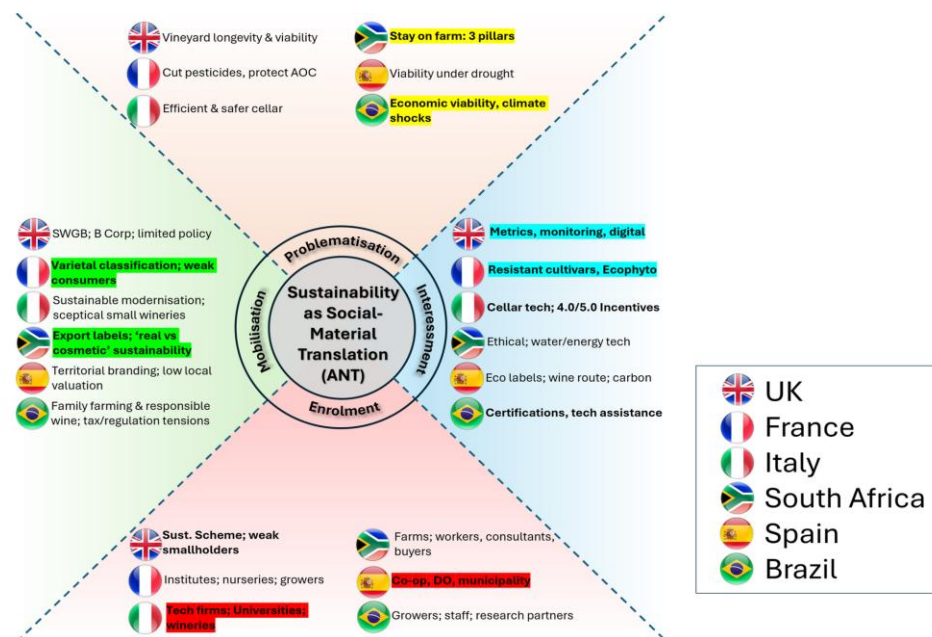
Different Brazilian actors mobilise slightly different emphases when they speak about sustainability, but these differences remain within a shared frame in the interview material. Some interviewees foreground structured governance and certification as evidence of serious commitment; others stress support for grape-growing families, the circular use of residues, and technical assistance; others highlight proximity to consumers, local sourcing, and tourism experiences. All, however, link sustainability to concrete practices rather than to slogans alone, consistent with views of sustainability as a contested and practice-based concept (Forbes; De Silva; Gilinsky, 2020; Gabzdylova; Raffensperger; Castka, 2009).

Controversies do appear, especially around the cost and bureaucracy of certifications, the distribution of responsibilities between wineries and growers, and perceptions that public policy oscillates between necessary support measures and regulatory burdens. In the interview material, these tensions are acknowledged but do not dominate the narratives; they are part of the ongoing negotiation of roles and expectations rather than open conflict, echoing the notion that sustainability stabilises only through struggles over meaning and legitimacy (Ählström; Egels-zandén, 2008).

4.7 Comparative evaluation of actor-network configurations

Across the six cases, the actor-network configurations described above exhibit distinct strengths and vulnerabilities rather than converging on a single “best” model of sustainability. In the United Kingdom, metrics and certification offer traceability and learning effects but create administrative burden and uneven enrolment.

Figure 2. Key findings for each country according to the phases of ANT



Source: developed by the authors (2025).

What unites them is not a shared definition of sustainability but a shared condition: the need to assemble heterogeneous actants into workable, if always provisional, alignments. Making these strengths and weaknesses explicit matters if sustainability standards and cluster policies are to build on existing networks' capabilities while addressing their blind spots.

5. Final considerations

Using Actor-Network Theory as its analytical lens, this study has treated sustainability in wine clusters not as a pre-given normative construct but as a situated socio-material accomplishment emerging from heterogeneous networks of human and non-human actants.

Across the six cases, what appears under the single label of “sustainability” is the contingent outcome of translation processes in which vines, pathogens, infrastructures, legal texts, metrics, technologies and climatic events co-shape the networks alongside human actors.

The comparative design suggests that sustainability trajectories are driven by distinct configurations of actants and devices rather than by fixed institutional frameworks or generic behavioural drivers. Metrics-driven coordination in one context, varietal innovation in another, process-technology modernisation, social standards, enotourism, technical assistance and extreme weather events in others: each assemblage combines technologies, legal classifications, scientific institutions and professional practices in specific ways. Within the analytical perspective adopted here, there is no underlying “real” sustainability that precedes these networks; instead, different networks produce distinct versions of sustainability that may coexist, overlap or collide.

The contribution lies in making these socio-material assemblages more visible and showing how wine clusters, often portrayed as coherent territorial entities, function as dynamic actor-networks where definitions of sustainability are continuously produced, challenged and reconfigured. The analysis has clear limitations. It is based exclusively on interviews without triangulation through observations, documents or quantitative indicators, a deliberate choice to avoid imposing external benchmarks on an ANT analysis. The networks traced are necessarily partial and perspectival, reflecting actors’ own problematisations and the researcher’s work of assembling the account.

Future research could follow additional actants and inscriptions, design longitudinal studies tracking specific interessement devices across territories, and elaborate ANT-inspired middle-range concepts for analysing sustainability assemblages in agri-food sectors. This work maps how multiple actor-networks assemble, contest and stabilise what counts as “sustainability” and opens a path for further developments grounded in the careful following of actors and their networks.

References

- ÄHLSTRÖM, J.; EGELS-ZANDÉN, N. The processes of defining corporate responsibility: a study of Swedish garment retailers’ responsibility. **Business Strategy and the Environment**, v. 17, n. 4, p. 230–244, 2008. DOI: 10.1002/bse.514.
- ANDERSON, K.; PINILLA, V. (ed.). **Wine globalization: a new comparative history**. Cambridge: Cambridge University Press, 2018. DOI: 10.1017/9781108131766.
- ANNUNZIATA, E. et al. The role of organizational capabilities in attaining corporate sustainability practices and economic performance: evidence from Italian wine industry. **Journal of Cleaner Production**, v. 171, p. 1300–1311, 2018. DOI: 10.1016/j.jclepro.2017.10.035.

- BEATTINI, G. Industrial sectors and industrial districts: tools for industrial analysis. **European Planning Studies**, v. 10, n. 4, p. 483–493, 2002. DOI: 10.1080/09654310220130194.
- BRAUN, V.; CLARKE, V. Using thematic analysis in psychology. **Qualitative Research in Psychology**, v. 3, n. 2, p. 77–101, 2006. DOI: 10.1191/1478088706qp063oa.
- CALLON, M. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. **The Sociological Review**, v. 32, n. 1_suppl, p. 196–233, 1984. DOI: 10.1111/j.1467-954X.1984.tb00113.x.
- FLORES, S. S. What is sustainability in the wine world? A cross-country analysis of wine sustainability frameworks. **Journal of Cleaner Production**, v. 172, p. 2301–2312, 2018. DOI: 10.1016/j.jclepro.2017.11.181.
- FORBES, S. L.; DE SILVA, T.-A.; GILINSKY, A. (ed.). **Social sustainability in the global wine industry: concepts and cases**. Cham: Springer, 2020. DOI: 10.1007/978-3-030-30413-3.
- GABZDYLOVA, B.; RAFFENSPERGER, J. F.; CASTKA, P. Sustainability in the New Zealand wine industry: drivers, stakeholders and practices. **Journal of Cleaner Production**, v. 17, n. 11, p. 992–998, 2009. DOI: 10.1016/j.jclepro.2009.02.015.
- GIULIANI, E. The selective nature of knowledge networks in clusters: evidence from the wine industry. **Journal of Economic Geography**, v. 7, n. 2, p. 139–168, 2007. DOI: 10.1093/jeg/lbl014.
- GIULIANI, E. Network dynamics in regional clusters: evidence from Chile. **Research Policy**, v. 42, n. 8, p. 1406–1419, 2013. DOI: 10.1016/j.respol.2013.04.002.
- LATOUR, B. On recalling ANT. **The Sociological Review**, v. 47, n. 1_suppl, p. 15–25, 1999. DOI: 10.1111/j.1467-954X.1999.tb03480.x.
- LATOUR, B. **Reassembling the social: an introduction to actor-network-theory**. Oxford: Oxford University Press, 2007.
- LAW, J. After ANT: complexity, naming and topology. **The Sociological Review**, v. 47, n. 1_suppl, p. 1–14, 1999. DOI: 10.1111/j.1467-954X.1999.tb03479.x.
- LAW, J. Actor network theory and material semiotics. In: TURNER, B. S. (ed.). **The new Blackwell companion to social theory**. Chichester: Wiley, 2008. p. 141–158. DOI: 10.1002/9781444304992.ch7.
- LUMIVERO. **NVivo**. Version 14. 2023. Available at: <https://lumivero.com/products/nvivo>.
- MARCON NORA, G. A.; ALBERTON, A.; AYALA, D. H. F. Stakeholder theory and actor-network theory: the stakeholder engagement in energy transitions. **Business Strategy and the Environment**, v. 32, n. 1, p. 673–685, 2023. DOI: 10.1002/bse.3168.
- OIV. **Development of sustainable viticulture**. Paris: OIV, 2004. Available at: <https://www.oiv.int/public/medias/2074/cst-1-2004-en.pdf>.
- OIV. **OIV general principles of sustainable vitiviniculture: environmental, social, economic and cultural aspects**. Paris: OIV, 2016. Available at: <https://www.oiv.int/public/medias/5766/oiv-cst-518-2016-en.pdf>.
- OIV. **OIV guide for the implementation of principles of sustainable vitiviniculture**. Paris: OIV, 2020. Available at: <https://www.oiv.int/public/medias/7601/oiv-viti-641-2020-en.pdf>.
- SANTINI, C.; CAVICCHI, A.; CASINI, L. Sustainability in the wine industry: key questions and research trends. **Agricultural and Food Economics**, v. 1, n. 1, p. 9, 2013. DOI: 10.1186/2193-7532-1-9.
- SZOLNOKI, G. A cross-national comparison of sustainability in the wine industry. **Journal of Cleaner Production**, v. 53, p. 243–251, 2013. DOI: 10.1016/j.jclepro.2013.03.045.
- ZEN, A. C. et al. Sustainability-oriented transition in clusters: a multilevel framework from induction. **Sustainability**, v. 14, n. 7, p. 4265, 2022. DOI: 10.3390/su14074265.