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Brazil Program

CATTLE TRACEABILITY IN BRAZIL

POLICY, MARKETS, AND IMPLEMENTATION

SEPTEMBER 2025

In partnership with

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ACKNOWLEDGMENT

This paper draws on insights from the event **"Traceability: Enhancing Transparency and Market Access,"** held virtually on August 21, 2025, as part of a year-long initiative on sustainable agriculture in the lead-up to COP30. The event was organized through a partnership among the Brazil Program at the Inter-American Dialogue, Embrapa, Arcos Dorados, Marfrig, and WWF. Moderated by **Giulia Branco Spiess**, Senior Associate at the Brazil Program, the session convened leading representatives from science, industry, government, and civil society to examine how cattle traceability can enhance transparency, competitiveness, and sustainability in the beef supply chain.

The discussion featured **Ivan Bergier**, Senior Researcher at Embrapa, who presented technological advances in network-based traceability systems and digital integration tools; **Mariana Fontalvo**, Veterinary Inspector at the Ministry of Agriculture and Livestock (MAPA), who outlined the National Plan for Individual Identification of Cattle and Buffaloes (PNIB); **Fábio Montossi**, Senior Researcher at Uruguay's Instituto Nacional de Investigación Agropecuaria (INIA), who detailed Uruguay's integrated meat traceability system; **Marcelo Secco**, Chief Executive Officer of Marfrig Uruguay, who described how the meat industry leverages Uruguay's traceability framework to create value and meet global market standards; and **Gabriel Serber**, Vice President of Social Impact and Sustainable Development (ESG) at Arcos Dorados, who analyzed the private sector's role in advancing sustainable, deforestation-free supply chains.

The insights generated during this dialogue form the basis of this paper, which synthesizes key findings and policy recommendations to be presented at COP30 as part of a broader agenda to promote sustainable agriculture in Latin America.

INTRODUCTION

Traceability has emerged as a central pillar shaping the future of agricultural and livestock production and trade. Beyond its original role in sanitary monitoring, it has evolved into a form of strategic infrastructure for global markets, supporting transparency, ensuring compliance with sustainability standards, and strengthening the credibility of both producers and consumers.

At its core, traceability is about understanding where agricultural products come from and the conditions under which they are produced. In the beef sector, this knowledge helps ensure compliance with environmental and human rights standards, safeguards access to export markets and provides the data companies need to meet their climate commitments. Traceability also enables product differentiation, whether through health assurances, stronger animal welfare standards, or claims such as "100 percent pasture raised." Ultimately, it has become the foundation of credibility and competitiveness in the global beef trade, playing a critical role in transforming the meat supply chain, particularly the cattle sector, to address urgent challenges such as climate change and deforestation.

Brazil, as the world's largest beef exporter, is central to this discussion. In 2024, the country accounted for 12 percent of the global cattle and buffalo herd and 15 percent of global beef production, according to the 2025 ABIEC Report. The industry has increasingly adopted data-driven approaches and new technologies, improving efficiency while facing growing scrutiny over its environmental impact.

This context underscores Brazil's systemic importance not only for global food security in the face of climate change but also for the challenges that lie ahead. As markets adopt deforestation-free regulations and tighten sustainability requirements, traceability has become a prerequisite for continued access to premium markets. Yet the path toward achieving full traceability remains complex. It requires coordinated action among government, research institutions, slaughterhouses, retailers, and producers, and Brazil still has considerable progress to make before reaching that goal.

CURRENT LANDSCAPE AND IMPLEMENTATION CHALLENGES

Significant progress has been made in key regions such as the Amazon, where the connection between deforestation and pasture expansion has become an increasing concern. However, this progress remains limited, as it primarily encompasses direct cattle suppliers to slaughterhouses. The main challenges to establishing effective traceability include the prevalence of informal and local markets and the difficulty of engaging indirect suppliers, most of whom are smallholders. These producers require targeted support, capacity-building, and appropriate incentives to be fully integrated into sustainable supply chains.

Existing programs have fallen short as well. Brazil's efforts to regulate cattle traceability date back to the 1934 decree on animal identification and were later reinforced by Law No. 12,097 of 2009 and by the creation of SISBOV, the Brazilian System of Identification and Certification of Bovine and Buffalo Origin, launched in 2002 to meet EU health standards. However, it never scaled beyond a niche due to high costs and operational burdens.

A significant step forward came recently, in 2024, when the Ministry of Agriculture and Livestock (MAPA) launched the **National Plan for Individual Identification of Cattle and Buffaloes (PNIB)**. This strategic plan for 2025–2032 establishes mandatory individual traceability by 2032 and creates a working group to guide its implementation, set to be gradual:

- **2025** – federal system operational
- **2026** – integration of state-level systems
- **2027–2029** – mandatory identification for animals in official health programs
- **2030–2032** – nationwide mandatory identification for all animals before their first movement

The PNIB represents the first national commitment to universal adoption and outlines a modern and ambitious framework, proposing a collaborative approach among federal and state governments, the private sector, and civil society. However, its timeline and operational rollout raise uncertainties in a country as large and diverse as Brazil. The high cost of identification devices risks discouraging adoption, particularly among small producers, while broader investments in infrastructure and technical training are still required. Compliance with international regulations, such as the EU Deforestation Regulation (EUDR), also adds pressure to the timeline. In addition, the plan focuses on sanitary security, failing to address the more urgent environmental and climate dimensions of cattle production.

Still, there are emerging responses and important initiatives underway.

The emerging responses to transform the meat supply chain, particularly in Brazil's cattle sector, involve a coordinated acceleration of policy, technology, and financial strategies focused on increasing transparency, driving sustainable production, and mitigating climate risks.

In the northern state of Pará, the Sustainable Cattle Program launched in 2023 requires all 26 million cattle in the state to be electronically tagged by 2026, a bold step to strengthen legal compliance and transparency.

The financial sector is also reshaping incentives with Brazil's banking federation (Febraban) requiring slaughterhouses to have complete traceability in place by 2025 as a condition for credit. International buyers are signaling similar expectations, with the Chinese Meat Association urging importers to avoid sourcing from high-risk areas.

Technology is beginning to fill some of the gaps, with tokenization and remote sensing tools helping to track cattle movements, verify land-use changes, and reduce the risk of cattle laundering. And across the sector, multi-stakeholder initiatives are gaining ground, reflecting the reality that deforestation is a systemic challenge that no single actor can resolve alone.

Due to the national system's focus primarily on sanitary security and its extended timeline, market actors (investors, retailers, and slaughterhouses) are encouraged to collaborate to create their own private, independent systems. These efforts require direct and indirect suppliers to share animal transport data for deforestation verification, highlighting persistent fragmentation that limits long-term progress.

While much has been done to advance traceability, success now hinges on coordinated action by government, research institutions, slaughterhouses, retailers, and producers.

THE TRACEABILITY ECOSYSTEM IN BRAZIL

Produced in partnership with Jane Lino - Proforest

Building an effective cattle traceability system in Brazil requires coordinated engagement across public institutions, private companies, research organizations, and civil society. While the federal and state governments define the legal and data infrastructure, implementation depends on partnerships that integrate technological innovation, financial mechanisms, and social inclusion. Together, these actors form a complex but increasingly convergent ecosystem that links traceability to broader sustainability and market-access goals.

A diverse ecosystem has emerged, anchored in collaborative initiatives that target specific segments of the cattle supply chain and biomes. These initiatives vary in governance, geographic scope, and level of data coverage, but collectively they demonstrate the growing convergence around transparency and deforestation and conversion-free production.

Civil Society Initiatives

Civil society and corporate coalitions have played a pioneering role in operationalizing traceability, especially in high-risk biomes.

The initiatives ***Beef on Track*** and the **Cerrado Protocol** bring together civil society organizations and companies from the cattle value chain and focus on monitoring and verifying socio-environmental compliance through what could be defined as "minimum traceability," which includes information only up to the direct supplier of the slaughterhouses.

The **Beef on Track** initiative operates primarily in the Amazon and is linked to the implementation of legal agreements overseen by the Federal Public Prosecutor's Office. It serves as a compliance mechanism for mandatory terms of adjustment signed by slaughterhouses and meatpackers, focusing on monitoring suppliers against deforestation and other socioenvironmental criteria such as slave labor lists.

The **Cerrado Protocol**, in contrast, is a voluntary framework focused on the Cerrado biome. It promotes collective action among meatpackers and downstream buyers seeking to apply Amazon-style transparency standards in regions where deforestation and ecosystem conversion is increasingly shifting.

Another critical initiative is the **Working Group on Indirect Suppliers (GTFI)**, which concentrates on the most complex segment of the supply chain: indirect suppliers. The GTFI promotes "intermediate traceability," covering rearing and backgrounding stages but not yet the breeding phase. Its work has advanced digital solutions and voluntary protocols for indirect supplier verification, representing a bridge between first-tier monitoring and universal systems.

These initiatives have significantly contributed to advancing cattle traceability, particularly through top-down approaches developed and tested with market-leading companies. However, they still face major limitations. They largely operate within the supply chains of major companies and do not yet encompass breeding farms. Expanding their impact will require government leadership to establish enabling public policies that extend traceability beyond market-driven systems.

Companies' Traceability Approaches

The private sector initiatives demonstrate that traceability has become both a compliance

mechanism and a strategic investment in market differentiation and brand credibility.

Agrotools, a leading Brazilian agtech company, has become a key player in advancing private-sector traceability. Working alongside Arcos Dorados, McDonald's largest franchisee in Latin America and the Caribbean, and McDonald's Corporation, the company developed digital systems that integrate geospatial intelligence, satellite imagery, and ESG analytics to ensure deforestation-free beef sourcing. The partnership allows comprehensive oversight of Arcos Dorados' supply network, which encompasses about 18,000 farms across Brazil and Argentina. Within this extensive network, around 3.6 million hectares are continuously monitored each month through regional supply pools, helping guarantee compliance with McDonald's deforestation-free standards

Other corporate initiatives have similarly integrated traceability into sustainability commitments. **Marfrig's Verde+ Program** aligns deforestation-free sourcing with net-zero and carbon-neutral beef goals, using traceability data to validate climate targets. The **Novo Campo Project**, supported by Arcos Dorados, combines traceability with sustainable intensification practices, monitored through indicators from the Mesa Brasileira da Pecuária Sustentável (MBPS).

Box 1 | Agrotools: Digital Solutions for Supply Chain Integrity

Produced in partnership with Breno Felix, Agrotools

Agrotools is a Brazilian agtech company that uses advanced digital tools to monitor and analyze rural territories in real time. Its platform combines satellite data, geospatial intelligence, and ESG metrics to help companies manage risk, ensure compliance, and make data-driven decisions across agricultural supply chains.

Among the company's initiatives, the work carried out with Arcos Dorados and McDonald's deserves attention. The partnership supports McDonald's long-term goal of maintaining socio-environmental monitoring and traceability policies that promote sustainable practices, focusing on deforestation-free supply chains.

Faced with the challenge of monitoring its entire beef supply chain and implementing the Deforestation-Free Beef Purchasing Policy at scale, McDonald's and Arcos Dorados sought advanced technological solutions. With the support of Agrotools as a partner for over ten years and using their Socio-Environmental Analysis solution combined with the Supply Chain Central Platform for indirect suppliers, the companies achieved the ability to:

• Continuously track socio-environmental criteria in Brazil and Argentina ensuring strict compliance in raw material sourcing.

• Identify critical risks such as deforestation, forced labor, embargoes, and livestock expansion in protected areas, aligning operations with sustainability policies.

• Review, enhance, and strengthen the company's Deforestation-Free Beef Purchasing Policy.

• Monitor supply chains and assess justifications in cases of non-compliance.

• Support the reintegration of noncompliant suppliers.

• Generate reports and interactive dashboards with strategic insights for multiple stakeholder levels (slaughterhouses, hamburger producers, Arcos Dorados, and McDonald's).

• Deliver analytical insights that inform key business decisions.

Through this partnership, McDonald's and Arcos Dorados have turned policy into practice embedding sustainability, transparency, and governance into one of the most complex supply chains in the global food service industry. The large-scale use of data through Agrotools' platform ensures reliable and traceable results for all parties involved.

The collaboration has led to significant outcomes: 100% of the beef supply chain is now monitored in priority countries, with compliance rates of 99.94% in Brazil and 98.98% in Argentina. The companies have jointly developed a socio-environmental policy applied at scale, based on a fully measurable and verifiable methodology, resulting in the monthly monitoring of 3.67 million hectares, 17,899 farms, and 5.1 million animals.

Multi-Stakeholder Coalitions and Platforms

Broader multi-stakeholder coalitions have consolidated traceability as a public policy priority. **The Brazilian Roundtable on Sustainable Livestock (MBPS)** and the **Brazil Climate, Forests and Agriculture Coalition** have established dedicated working groups on traceability. These forums connect private companies, government agencies, and research institutions to develop national policy proposals, align corporate monitoring standards, and build consensus on data integration.

Together, these coalitions have helped frame traceability as both an environmental governance tool and a competitiveness strategy. Their coordinated efforts are particularly important in ensuring that private-sector innovation aligns with emerging national frameworks such as the National Plan for Individual Identification of Cattle and Buffaloes (PNIB) and the AgroBrasil+Sustentável platform.

Government Initiatives

At the federal level, the Ministry of Agriculture and Livestock (MAPA) coordinates the country's official traceability agenda.

The National Plan for Individual Identification of Cattle and Buffaloes (PNIB), launched in 2024, establishes mandatory national traceability by 2032 and defines the governance structure for universal adoption.

The AgroBrasil+Sustentável Platform aims to integrate data from multiple systems into a unified "data lake" connecting sanitary, environmental, and commercial registries. This integration is central to ensuring Brazil's compliance with EUDR and other international frameworks.

SERPRO, the Federal Data Processing Service, supports the digital services behind data integration efforts across ministries.

Earlier programs, such as SISBOV, laid out the groundwork but remained limited due to voluntary participation and cost barriers. The PNIB and AgroBrasil+Sustentável now provide a renewed institutional architecture that can link these legacy systems into a cohesive national framework.

The Program Carne Legal (Legal Beef) is an initiative launched in 2009 by Brazil's Federal Prosecution Service (Ministério Público Federal — MPF) using TACs (Termos de Ajustamento de Conduta) to enforce environmental and labour legality in the beef supply chain in the Amazon. The program is supported by Beef on Track among other civil society initiatives.

The Sustainable Cattle Program in Pará (2023) exemplifies subnational leadership. It mandates electronic tagging for all 26 million cattle in the state by 2026, linking traceability to environmental compliance and market access.

The SeloVerde Platform, developed by the Federal University of Minas Gerais (UFMG) and implemented in Pará, Minas Gerais, and Espírito Santo (and expanding to Acre, Tocantins, and Maranhão), represents Brazil's most advanced "universal" traceability approach. By integrating official data from the *Rural Environmental Registry* (CAR) and *Animal Transit Guides* (GTA), SeloVerde enables batch-level monitoring across commodities.

Science, Technology, and Innovation

Research institutions have been instrumental in developing the technologies that underpin traceability.

Scientific institutions, particularly Embrapa, play a foundational role in providing the technological backbone of Brazil's traceability ecosystem. Through tools such as the BovTrace API and the Traceability Network Model, Embrapa has demonstrated how digital integration and data interoperability can support both public policy and private certification systems, aligned with territorial and individual tracing initiatives (Bergier, 2025).

Universities and research networks generate analytical and policy frameworks that connect traceability to deforestation monitoring and climate metrics; notably, the Federal University of Minas Gerais (UFMG) has led the development and expansion of SeloVerde across states.

Box 2 | Scientific Leadership through Brazil's Embrapa

Brazil's scientific institutions have demonstrated leadership in developing the technological tools required for modern traceability. Brazil's Embrapa has been central to this progress, piloting systems that show how traceability can evolve from a compliance mechanism into a core infrastructure for livestock governance.

1. Municipality-Level Network Traceability (2022–2024):

Using Animal Transit Document (GTA) data from the state of Mato Grosso do Sul (21 million cattle herd size) between 2022 and 2024, Embrapa modelled cattle flows across municipalities and states. The number of connections rose from 24 to 59 in just two years, revealing an increasingly integrated supply chain. An important finding was the emergence of "return from slaughter" flows, absent in previous years, which indicate greater circularity and stronger monitoring loops in the system. This suggests that supply chains are becoming more certifiable and aligned with market standards, partly as a response to policy incentives, such as the PROAPE program in Mato Grosso do Sul.

Within this network, the municipality of Guia Lopes da Laguna stood out as a key hub, especially in the slaughter phase. Its centrality is explained by both its strategic location and its historical role in the cattle sector, with connections extending to states such as Goiás, Mato Grosso, Minas Gerais, São Paulo, Rondônia, and Bahia. This highlights how logistics and infrastructure shape supply chain governance and help align operations with traceability requirements.

2. BovTrace API:

Developed by Embrapa and hosted on the AgroAPI platform, the BovTrace API (Application Programming Interface) enables the standardization of individual cattle transfer records, accompanied by cryptographic codes or tokens of electronic GTA, CAR and Invoice, all stored as a new single digital token. In practice, this means that, in digital infrastructures, data owners can safely share sensitive information about animal movements, traditionally stored in different and often siloed systems.

By enabling this secure and interoperable digital ecosystem, BovTrace API allows data to be exchanged seamlessly across public and private certification systems, improving transparency and auditability. It also reduces

the risks of fraud and increases trust among stakeholders along the supply chain. Taking altogether, the innovation supports the modernization of Brazil's livestock sector and strengthens the country's alignment with international trade and sustainability requirements.

These examples illustrate that science and innovation are already providing the tools for a more transparent and efficient supply chain. Embrapa is a key stakeholder, alongside MAPA, SERPRO, and the private sector, in developing these national, governmental, voluntary, and safe digital ecosystems.

The strategic task ahead is to integrate these advances into a cohesive framework, turning traceability into an ethical and strategic instrument that connects sustainability goals with verifiable, data-backed practices and strengthens Brazil's leadership in the digital transformation of global markets.

LESSONS FROM THE REGION: URUGUAY'S 100% TRACEABILITY SYSTEM

Produced in partnership with Ing. Agr. PhD. Fabio Montossi, National Institute of Agricultural Research (INIA) – Uruguay

Uruguay has long been recognized as one of the countries that has most advanced the traceability debate. Each animal carries a digital identity that ensures transparency, trust, and competitiveness. This is part of a broader vision of sustainable growth based on five pillars: innovation, green and ethical production, social inclusion, market and consumer satisfaction, and scientific and technological excellence. The idea of producing and exporting not only meat, but trust, has become central to Uruguay's agricultural sector.

The country uses the National Livestock Information System (SNIG), a digital platform integrating technology, governance, and producers. Created in 2004, the SNIG tracks cattle from birth to slaughter, connecting data on animal health, food safety, and trade. Beginning as a voluntary initiative, it became mandatory for all calves born after 2006 and reached full national coverage by 2011. Today, it monitors over 11.5 million head of cattle across roughly 45,000 farms.

The SNIG included i) official ear tagging for individual animal identification, ii) recording of key events such as births, transfers, movements, deaths, and slaughter, and iii) integration with national databases like DICOSE (livestock inventories), INAC (meat and carcass data), SIGOR (producer information), and export control systems.

According to the report Global review of livestock traceability systems (Project V.ISC.2407), while other countries, including Brazil, rely on partial or voluntary systems, Uruguay's infrastructure ensures real-time traceability and transparency. The same report also points out that Brazil, together with Argentina and Paraguay, usually applies traceability only to cattle intended for export and focuses on identifying farms rather than individual animals. Uruguay, on the other hand, stands out for connecting its national registry (SNIG) with health monitoring and trade certification systems, allowing information to be verified in real time.

SNIG data helps drive research and innovation by connecting traceability with information about genetics, production, and the environment. Institutions like INIA and Universidad de la República use these records to study meat quality, methane emissions, and new digital tools such as labels and blockchain systems that link producers and consumers. The platform also provides data on land use, animal density, and greenhouse gas emissions, supporting certification programs based on verified claims like "grass-fed," "carbon neutral," or "antibiotic-free."

Overall, Uruguay's approach treats traceability as a state policy and public good, not just a technical requirement. It sustains animal health and border security, enhances market access, and reinforces Uruguay's image as a reliable, ethical, and science-based producer.

Comparing Uruguay and Brazil is not straightforward given their different sizes and institutional realities. Yet, Uruguay's experience shows how treating livestock traceability as a long-term national strategy can generate innovation, trust, and market resilience. It demonstrates that traceability, when seen as part of a broader development agenda, becomes an engine for sustainability and competitiveness.

TOWARD SYSTEMIC INTEGRATION

The current landscape of initiatives reveals a dual reality. Brazil has become a rich laboratory for traceability pilots and voluntary systems, yet full integration across regions and production stages remains incomplete. **Achieving universal traceability will require interoperability between public and private databases, standardized methodologies for deforestation and conversion verification, and alignment of incentives across producers, buyers, and regulators.** Public financial institutions are also driving change, with Febraban's requirement that slaughterhouses achieve full traceability by 2025 serving as a clear example of this effort.

Government leadership is crucial to transition from voluntary to universal traceability, but lasting success will depend on continued collaboration with the private sector, civil society, and scientific institutions. When coordinated under a shared vision that connects environmental integrity, market access, and inclusion, Brazil's traceability ecosystem has the potential to become a global benchmark for sustainable cattle production.

The Demand-Side Push: Buyers, Meatpackers, and Finance

On the demand side, pressure is mounting from buyers, major meatpackers, and financial institutions. Their message is that sustainability commitments, verifiable zero-deforestation sourcing, and robust traceability are now conditions for market access.

Arcos Dorados illustrates how these pressures are reshaping corporate strategies. The company has gone beyond simply avoiding cattle from deforested areas and is piloting ways to source beef from the region without contributing to deforestation. Through its participation in the Novo Campo Project, it supports intensive, sustainable production systems that yield four to five times more beef per hectare, reducing incentives to clear new land. The project uses sustainability indicators developed by the **Brazilian Roundtable for Sustainable Livestock (Mesa Brasileira da Pecuária Sustentável - MBPS),** covering everything from animal health to natural resource use. Compliance is verified through GIS-based monitoring tools, and every participating farm signs a pledge for continuous improvement. For Arcos Dorados, traceability underpins consumer trust in food safety, product origin, and responsible sourcing, giving the company a competitive edge.

Marfrig has also woven traceability on its broader sustainability agenda. In 2020, it launched the *Verde+* program, committing to net-zero emissions by 2050 and eliminating deforestation from its supply chains by 2025. To reach these goals, Marfrig set ambitious emission-reduction targets and joined other agribusiness giants in promising zero conversion of native habitat in the Cerrado by 2030. It has also invested in product innovation, partnering with Embrapa to launch a line of "Carbon Neutral Beef" sourced from integrated agroforestry systems where methane emissions are offset by tree planting. In the previous roundtable, **Embrapa** showed that integrated livestock-crop-forestry systems with 250 to 350 trees per hectare can capture 18 $tCO_2eq/ha/year$, neutralizing emissions from up to 12 adult cattle, with each tree fixing 63.9 kg CO_2eq per year. Complementary initiatives, such as testing tannin-based feed additives, have already reduced methane emissions from cattle by around 15 percent. In Uruguay, Marfrig has gone further, integrating traceability into regenerative practices and ecosystem monitoring, turning environmental value into a point of market differentiation.

In Uruguay, Marfrig has been leading initiatives through its program Adding Environmental Value to Livestock Production (2024–2025). The project focuses on validating ecosystem indicators on farms, promoting regenerative practices, and supporting education in rural areas. By linking consumer expectations to production systems and coordinating efforts with research institutions, certification schemes, and global partners, Marfrig illustrates how companies can integrate traceability into broader strategies that enhance credibility and differentiation in international markets.

THE CASE FOR UNIVERSAL TRACEABILITY

Contribution of Raoni Rajão, Professor of Environmental Management and Social Studies of Science and Coordinator of the Environmental Modeling Technology Center at the Federal University of Minas Gerais (UFMG); Senior Fellow at the Inter-American Dialogue Brazil Program

Any environmental traceability program capable of credibly reducing land-use change must be universal in scope. Universality implies that all farmers, including the ones with incentives to conceal non-compliant behavior, are monitored within a single reference system. Any design that admits self-selection, or covers primarily actors willing to be monitored, creates a structural blind spot: the group most likely to self-exclude is precisely those producers involved in illegal deforestation. Consequently, non-universal systems cannot generate reliable estimates of compliance at a landscape scale. They cannot credibly segregate "deforestation-free" flows because they leave unobserved segments that may leak non-compliance.

Private systems, such as those operated by Agrotools, help mitigate the blind-spot problem by analyzing all farms registered in the Rural Environmental Registry (CAR), providing spatial universality. However, these databases do not include the detailed personal or transactional data necessary to achieve complete end-to-end supply-chain traceability, particularly in cattle systems that involve multiple production stages and farm transfers. Without access to official data such as sanitary animal transportation guides (GTAs), personal identifiers within the Rural Environmental Registry, or other state-held provenance records, private systems face structural limits in connecting both direct and indirect suppliers in the way required by the European Union Deforestation Regulation (EUDR) and other international market standards.

Brazil's public traceability architecture is now bifurcated between (1) a voluntary, individual approach and (2) a universal, batch-based approach. The Ministry of Agriculture champions the voluntary/individual path through *Agro+ Sustentável* and will channel further investments in individual traceability. While this approach holds technical merits, especially for product-level claims, it is structurally bound by participation incentives. By design, it will not reach the population associated with concealed deforestation. It cannot deliver deforestation-free supply chains on its own unless it eventually integrates the data already held by the federal government.

To date, individual traceability systems encompass fewer than two thousand farms out of more than seven million registered in CAR. Given the high per-unit costs of individual tagging and monitoring, such systems are structurally unlikely to achieve coverage comparable to GTA-based architecture. They are likely to exclude smallholders. In any case, Agro+ Sustentável could still play an essential role in the future by integrating different private certifications and state-level traceability systems.

The universal, batch-based approach is exemplified by *SeloVerde*, implemented in Pará, Minas Gerais, and Espírito Santo and now being rolled out in Acre, Tocantins, and Maranhão. *SeloVerde*

integrates official data already provided by farmers (notably CAR and GTA) and currently covers approximately 1.5 million farms. It has demonstrated the ability to provide full traceability for volumes of soy, beef, and coffee sufficient to meet European demand under deforestation-free rules. Batch-level data such as GTA are fully compatible with the EUDR and with other stringent market regimes, insofar as they rely on the same data infrastructure already used to trace soy and other agricultural commodities for export compliance. It can also be integrated with other public and private platforms through an application programming interface (API), enabling large buyers to screen and analyze thousands of farms automatically.

Greater buyer awareness that universal traceability already exists at production-relevant scale is essential to accelerating the transition to deforestation-free supply chains. The advantages of universal, batch-based traceability have not been sufficiently evident to international buyers, who often continue to fund pilot initiatives that cannot scale to universal coverage or that require decades to mature.

When buyers preferentially contract from jurisdictions that have invested in transparency and universal traceability, they help strengthen state-level political coalitions for data integration and increase the likelihood that federal programs will converge toward universal architectures.

FINAL CONSIDERATIONS

Brazil is among the world's largest beef producers and exporters and plays a decisive role in shaping how global markets reconcile productivity, climate, and sustainability goals. Yet implementing a fully functional, nationwide traceability framework remains one of its most complex challenges, given the country's continental scale, institutional diversity, and mix of production systems.

Uruguay's experience illustrates the transformative potential of public–private collaboration. When traceability is treated as a state policy and a public good, it becomes not merely a sanitary control instrument but a platform for innovation, certification, and market differentiation. For Brazil, the path forward lies in leveraging its technological sophistication, robust data infrastructure, and dynamic private sector to create a system that is both universal in scope and inclusive in practice.

From the discussions convened for this paper, four key priorities emerge:

- **System integration and stakeholder engagement.** Brazil's progress will depend on connecting public registries, private monitoring tools, and certification systems.

- **Achieving data sharing safety** and **interoperability across public and private data platforms** will enable a more comprehensive, real-time understanding of production landscapes and compliance levels.

- **Producer inclusion.** Expanding access to traceability for small and medium producers requires not only regulatory mandates but also financial instruments, technical assistance, and shared-risk mechanisms. The private sector is already leading in this regard. Companies such as Marfrig and Arcos Dorados demonstrate that inclusion, transparency, and profitability can reinforce each other when traceability is linked to tangible market incentives.

- **Function over form.** Traceability should be viewed as a strategic infrastructure, not as a bureaucratic requirement. When designed as a collaborative ecosystem anchored in data transparency and mutual accountability, it strengthens the entire value chain, driving environmental integrity, food safety, and consumer trust.

Brazil's current landscape presents a dual reality. The country has become a rich laboratory for pilot projects and voluntary traceability systems, yet it still lacks full-scale integration across regions and production stages. A systemic approach will require stronger data sharing safety and interoperability between public and private data systems and better alignment of incentives across actors.

Government leadership is essential to move from voluntary to universal traceability. This transition must be supported by clear regulatory frameworks, financial mechanisms for producer inclusion, and the consolidation of shared technical standards and trustful governance. At the same time, private-sector and civil society actors bring the agility, innovation, and field capacity necessary to operationalize these frameworks.

Ultimately, Brazil's traceability ecosystem functions as a dynamic network of public and private stakeholders. When coordinated under a shared vision that links environmental integrity, market access, and inclusive development, it has the potential to transform the sector into a model of sustainable production and transparent governance.

The alignment between public initiatives and private innovation remains one of Brazil's greatest advantages. Private companies are already investing in monitoring tools, digital platforms, and supplier engagement models that reinforce and extend state-level systems. Their leadership is critical to accelerating digital data sharing ecosystems, harmonizing incentives, and embedding sustainability as a core dimension of competitiveness.

If Brazil succeeds in aligning its governance frameworks with this model of public–private collaboration, grounded in digital transformation and inclusion, it will not merely comply with global sustainability standards but help define them. Under such a framework, traceability becomes shared-value infrastructure and a practical mechanism through which productivity, transparency, and environmental integrity advance together.

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