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Intelligence for sustainable trade

Assessing facility-level risks in commodity supply chains: A supply shed analysis of Brazilian slaughterhouses

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Front cover image: Cowboys herd cattle in Brazil (Joa Souza/Shutterstock.com)

Executive summary

Facility-level risk assessment is increasingly important to assess and report on environmental and social sourcing risks in voluntary and regulatory frameworks, both due to widespread gaps and limitations in farm-level traceability at-scale, and to help enable more collective action around shared sourcing risks. This is especially the case for the Brazilian cattle sector where large amounts of cattle-driven deforestation are not traceable in today's supply chains and suppliers exist in highly interconnected networks that are shared by multiple slaughterhouses. However, there is limited comprehensive, high-quality open data on agricultural commodity facilities (e.g. slaughterhouses) or best-practice guidance and standardised methods to estimate facility supply sheds and associated risks.

To bridge this gap and complement existing traceability efforts, we analyse four existing approaches for assessing cattle supply sheds in the Brazilian Amazon and apply one of these methods (municipality weighted) to calculate cattle supply sheds and associated cattle deforestation risks for 1,249 slaughterhouses across the whole of Brazil. The dataset is publicly available on trase.earth.

A comparison of these four methods in the Brazilian state of Pará shows that the size and shape of the supply sheds vary markedly between the methods. The use of the radius method, despite its widespread use in estimating supply sheds, correlates poorly with all three of the data-driven methods that use logistical data to map supply sheds. Methods that weight volumes from different areas within a supply shed, rather than assuming uniform sourcing across the board, help companies and financial institutions prioritise their efforts. This approach highlights specific locations that provide significant volumes while facing higher risks. However, gaps in publicly available data on cattle movements and transactions remain a key constraint for adopting these data-driven methods.

We estimated supply sheds and associated cattle deforestation exposure for 1,249 slaughterhouses in Brazil using a municipality weighted approach. This required using two different datasets and methods due to data limitations, reflecting the challenge in accessing traceability data. The results illustrate that the exposure of slaughterhouses to cattle deforestation in their supply sheds is highly variable. Only 33 out of 1,249 slaughterhouses accounted for 60% of the deforestation exposure and an additional 90 slaughterhouses contributed 30%, which means that 1,030 slaughterhouses contributed less than 10% of Brazil's cattle deforestation. Within supply sheds, sourcing volumes and deforestation exposure are also highly concentrated; while the median number of municipalities in each slaughterhouse's supply shed was 123, the median number accounting for 50% of sourcing was only nine.

Open data on supply sheds is particularly useful for downstream companies and financial institutions that have limited access to traceability information to assess and report on deforestation and scope 3 emissions, and to target engagement with their suppliers and clients. This is illustrated in an anonymised case study of how a downstream buyer is already using this data.

"Open data on supply sheds is particularly useful for downstream companies and financial institutions that have limited access to traceability information"

Supply shed data is relevant to meatpackers and governments as a complementary risk assessment tool to existing traceability data. Supply shed data also can support targeted investments in improving traceability, legal compliance and incentives in municipalities with high deforestation and legal compliance risks. Supply sheds (and the underlying analysis of the indirect supply chain network of farms) also evidence shared risks across slaughterhouses and sourcing companies, and therefore the relevance of landscape initiatives that share costs and help mitigate collective risks across supply shed landscapes and suppliers.

While this study is focused on Brazilian cattle, its findings are relevant for other commodity supply chains. Its key recommendations are:

1. **Governments need to invest in improving the quality and availability of existing traceability data.** In the case of Brazilian cattle, this includes investing in a national GTA/CAR batch traceability system for cattle that builds on existing datasets and tools (e.g. state-level traceability platforms such as SeloVerde) and prioritises improvements in data quality and transparency to improve connections between GTA and CAR. This can help make the most of these existing datasets while the government invests in an individual cattle traceability and socio-environmental monitoring system over the coming decade.
2. **Companies and financial institutions can use supply shed data as a risk assessment tool** where traceability data is not available and in cases where it has gaps or limits, as is the case currently for Brazil cattle. Approaches that utilise logistics data are more accurate than estimating simple circular sourcing zones around facilities. Methods that weight sourcing volumes within supply sheds (often to regions close to facilities) rather than assuming uniform sourcing can help companies and financial institutions prioritise sourcing regions that provide high volumes and are exposed to higher risks.
3. **Improved coordination among standard-setters is needed to provide aligned best-practice guidance on data-driven methods** to estimate facility supply sheds and associated social and environmental impacts and dependencies that go beyond circular sourcing zone (radius method) approaches. Standards also need to encourage corporate disclosure and risk assessment using these methods where there are gaps in farm-level traceability.
4. **Identify opportunities to address shared risks and share costs.** The fact that the majority of deforestation occurs in areas outside the reach of current GTA/CAR data, combined with the complexity inherent in the highly connected network of slaughterhouse suppliers, underscores the clear business case for landscape-scale investments in farmer compliance, and social and environmental monitoring systems. Where risks are inherently shared across the network of suppliers (especially in the absence of individual traceability and monitoring systems), pre-competitive investment in supporting and incentivising legal compliance by producers can reduce risks across the supply sheds, thereby reducing the cost burden for achieving compliance for individual companies. Similarly, leveraging government investments in pasture restoration, governance and monitoring systems can enable sector-wide progress.

"Approaches that utilise logistics data are more accurate than estimating simple circular sourcing zones around facilities."

Introduction

This report assesses traceability challenges in Brazil's cattle supply chain and the relevance of using supply shed risk assessments as a complementary tool to farm-level traceability in assessing and mitigating risks. It assesses different methods for estimating cattle supply sheds and applies a municipality-weighted method to calculate cattle supply sheds for 1,249 slaughterhouses across Brazil. It concludes with a case study that shows how downstream companies are using this data in their risk assessments and makes recommendations for meatpackers, governments, downstream companies, financial institutions and standard setters. The report is based on research by Trase and Do Pasto ao Prato.

The role of geospatial supply sheds in managing social and environmental risks in commodity supply chains

There is increasing demand from voluntary initiatives, best-practice guidelines and mandatory regulations for facility-specific geospatial data on supply chain risks. This includes the Taskforce on Nature-related Financial Disclosures (TNFD) and its Locate, Evaluate, Assess, Prepare (LEAP) methodology, the EU Deforestation Regulation (EUDR), the OECD-FAO Business Handbook on Deforestation and Due Diligence in Agricultural Supply Chains, and the Accountability Framework Initiative's operational guidance.

Farm-level traceability remains highly challenging if not practically impossible in many agricultural commodity supply chains due to large numbers of smallholder farmers, complex supply chains, as well as a dependence on indirect supplies. Even where farm-level traceability is available, this data is not readily available to downstream companies or financial institutions.

In this context, and where farm-level traceability systems remain under active development, traceability to primary aggregation points (e.g. cooperatives, mills or slaughterhouses) and the assessment of social and environmental data in their potential sourcing regions (supply sheds) is an important risk assessment tool.

While the principles of using supply sheds in supply chain risk assessment have been widely adopted by voluntary frameworks, there is no standardised method for how to assess and report on supply shed risks. Key barriers to calculating supply sheds include identifying and locating aggregation facilities and validating sourcing zones and producers for both direct and indirect supply.

The relevance of supply sheds in assessing cattle supply chains risks

Farm-level traceability remains a significant challenge in cattle supply chains due to their length and complexity. Cattle normally pass through a number of farms before slaughter, and farms often specialise in specific stages of production such as breeding, rearing and finishing. While cattle supply chains are often presented as linear and tiered, in reality they operate as hyperconnected networks because individual farms sell to many other farms and/or slaughterhouses, and slaughterhouses share many of the same supplier farms.

"Farm-level traceability remains a significant challenge in cattle supply chains due to their length and complexity."

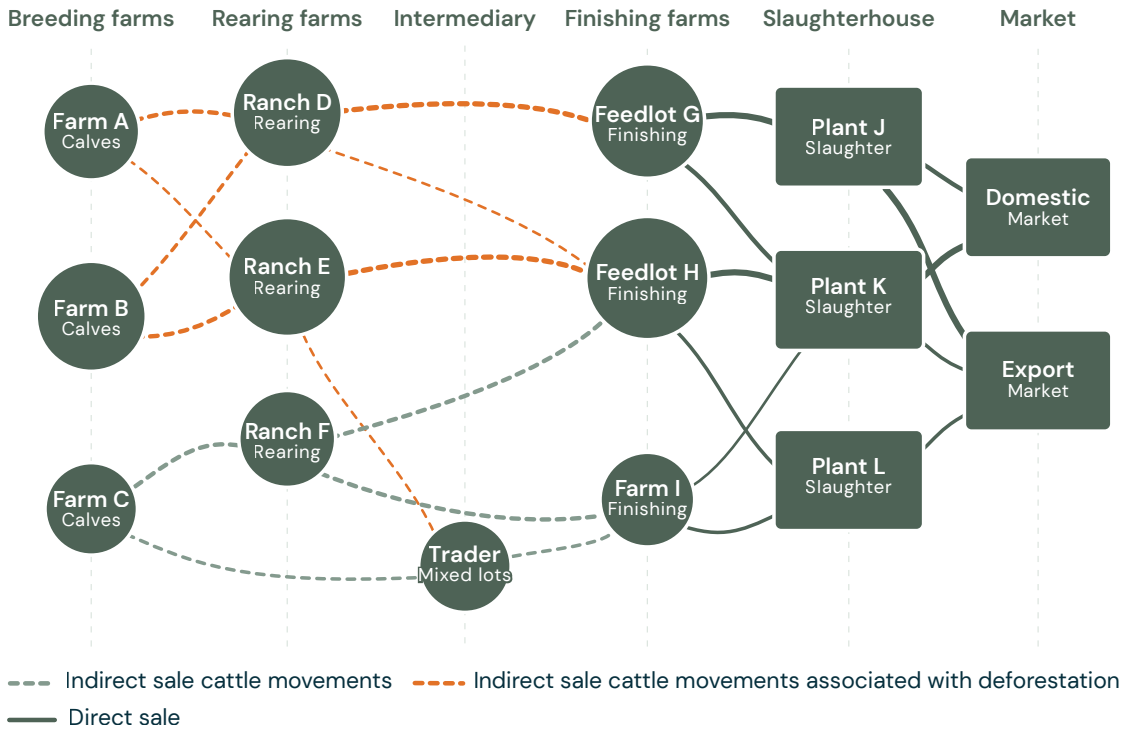

Figure 1: Simplified representation of Brazil's cattle supply chain as a network of breeding farms, rearing farms, finishing farms, traders, slaughterhouses and markets.

When mapping the supply chain beyond a slaughterhouse's direct suppliers, the number of indirect suppliers grows exponentially at each upstream tier. This is exemplified by looking at the JBS slaughterhouse in Marabá, Brazil. Using cattle movement records (*Guia de Trânsito Animal, GTA – see box p 9*) batch traceability data, the number of potential suppliers rapidly grows at each tier, going from 859 direct suppliers to more than 300,000 tier 3 suppliers (Figure 2). Moreover, suppliers often supply many different slaughterhouses. For example, the direct suppliers to JBS's Marabá slaughterhouse also sell to many other slaughterhouses across Brazil.

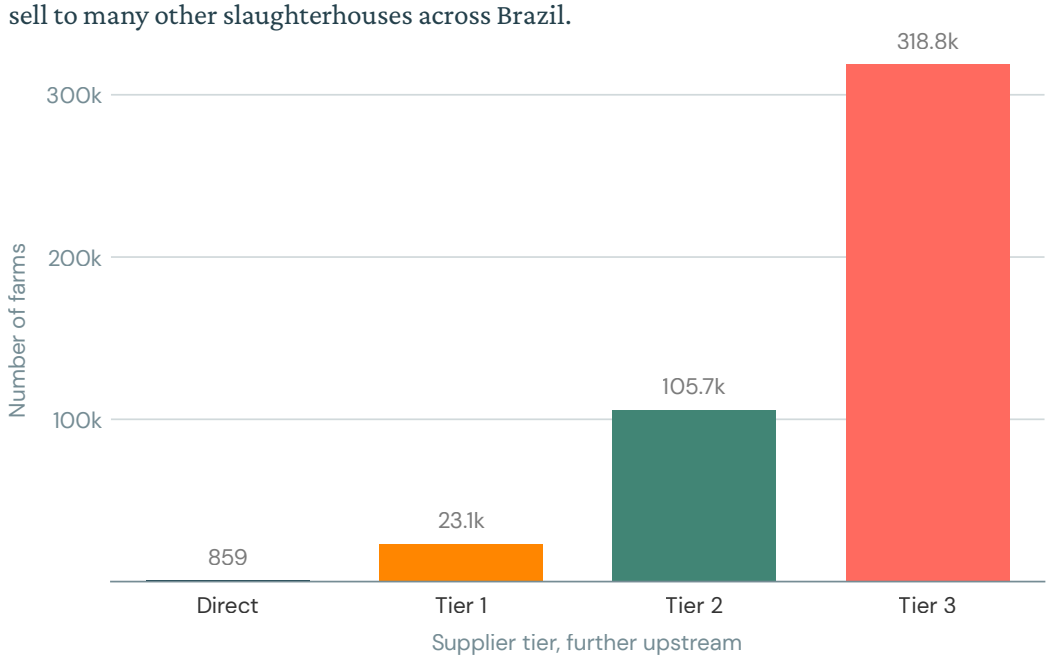

Figure 2: The number of farms potentially supplying the JBS slaughterhouse in Marabá, based on cattle movement records (GTA) during 2020–2022.

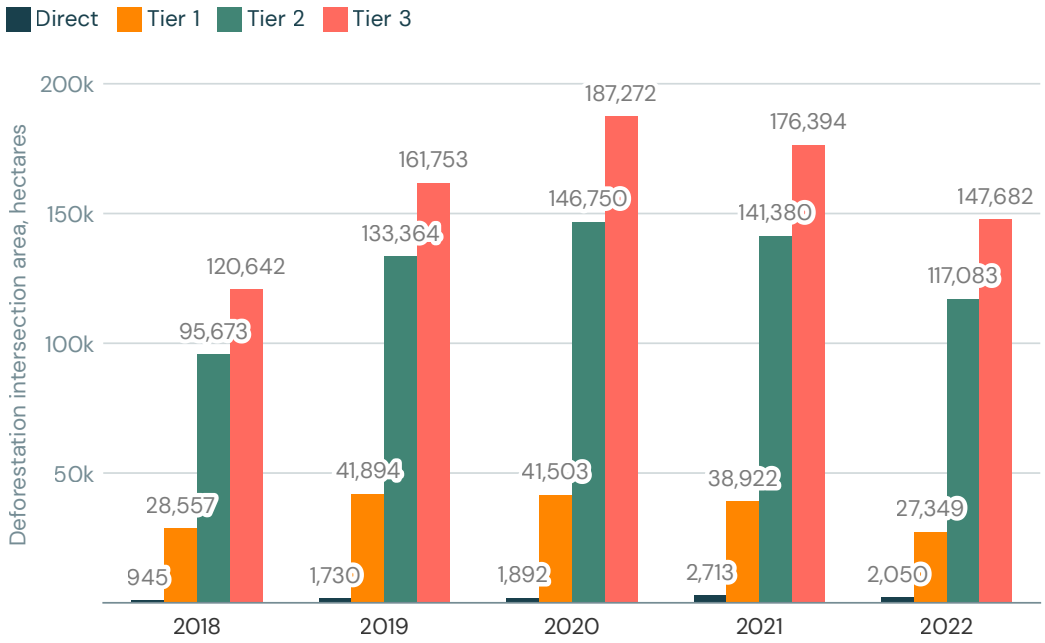

Figure 3: Deforestation exposure on potential supplier farms per tier for JBS Marabá slaughterhouse based on identified suppliers in the supply shed up to tier 3 using GTA/CAR data and based on Brandao (2023) methods.

Importantly, exposure to deforestation also rises further upstream in the indirect supply chain. For example, in 2022, potential tier 3 suppliers mapped in JBS Marabá's supply shed were exposed to 147,682 hectares (ha) of cattle deforestation (Figure 3). This is also evidenced in a number of studies that demonstrate that deforestation and illegal risks are much more prevalent among indirect suppliers than direct suppliers. Examples include a study of beef exports from the Brazilian states of Mato Grosso and Pará which found that 48% of exports were potentially linked to illegal deforestation when considering indirect suppliers to meatpacking companies compared to 12% when looking only at direct suppliers (Rajao, 2020). A study by Gibbs et al. 2026 found that meatpackers in Mato Grosso and Para with zero-illegal cattle deforestation agreements known as TACs (*Termo de Ajustamento de Conduta*) were exposed to more than twice the amount of deforestation in their indirect supply chain than their direct suppliers.

To date, many slaughterhouses only monitor the legal compliance of direct suppliers under the TAC agreements that have been signed between individual slaughterhouses in the Legal Amazon and the Federal Public Prosecutor's Office (*Ministerio Publico Federal, MPF*). However, there is clear recognition of the need to improve traceability and monitoring of indirect suppliers. The Brazilian Working Group on Indirect Suppliers of Cattle developed guidance on good practices for monitoring of tier 1 indirect suppliers, and in March 2026 MPF announced changes to the TAC monitoring rules to include indirect suppliers with an initial focus on tier 1 indirect suppliers (GTFI, 2026). The Brazilian Roundtable on Sustainable Livestock and the Brazilian Coalition on Climate, Forests and Agriculture have also put forward a proposal for batch-level traceability from farms to slaughterhouses (primary aggregation points) as part of a wider phased approach in the development of an individual traceability system (Brazilian Coalition on Climate, Forests and Agriculture and the Brazilian Roundtable on Sustainable Livestock, 2024).

These all recognise the need to use cattle movements records and rural property boundary data (see box on GTA and CAR p 9) to rapidly roll out the monitoring of indirect suppliers despite the inherent limitations that this data was not designed for this purpose.

These datasets are already used by existing indirect cattle traceability tools such as Visipec and SeloVerde as well as MPF to enable batch traceability of the indirect supply chain. However, recent studies have shown that there are more significant gaps in the GTA/CAR batch traceability data than previously recognised and that deforestation exposure in the untraced part of the supply chain is even greater than in the indirect supply chain. For example, a study by Brandão et al (2023) estimated that 66% of deforestation occurs outside the property boundaries of identified suppliers using GTA/CAR traceability data. Another study by Gibbs et al (2026) in Pará and Mato Grosso found that 56% of pasture properties identified using MapBiomas data were not in the GTA/CAR dataset used by the study because they were operating outside the GTA, or there were issues in matching the GTA with CAR data. This study also found that 40% of deforestation was in auxiliary properties of direct and tier 1 indirect suppliers identified in the GTA/CAR dataset.

Reasons for gaps in the available GTA/CAR traceability data include gaps in matching GTA to CAR, cattle movements without GTA including auxiliary properties, as well as cattle movements where the animal owner is not the property owner. (Amigos da Terra, Boi na Linha, Imaflora, 2024; Gibbs, 2026). These gaps highlight important limits of GTA/CAR traceability data to monitor the indirect cattle supply chain and the real risks that cattle raised on recently deforested land near these properties may still enter the supply chain.

While investments in improving the transparency and quality of datasets that underpin GTA/CAR farm-level traceability systems will be important (for example, by requiring GTA to embed CAR as part of investments in strengthening traceability systems), in this context more robust and available data on slaughterhouse supply sheds offers a complementary risk assessment tool that is currently the only means of estimating the full extent of potential risk exposure of a given slaughterhouse and to do so for entire regions or across all of Brazil. This supply shed data can also evidence the need for targeted collaborative action to mitigate shared risks across shared suppliers and overlapping sourcing regions.

"More robust and available data on slaughterhouse supply sheds offers a complementary risk assessment tool"

GTA and CAR traceability data

Cattle movement records (*Guia de Trânsito Animal, GTA*) detail the movement of batches of cattle between properties, listing the date of each movement, the farms or slaughterhouses sending and receiving cattle, the number of cattle, and their ages and sex.

The Brazilian Rural Environmental Registry (*Cadastro Ambiental Rural, CAR*) is a public registry of rural property boundaries where landowners self-declare property boundaries and land-use designations that must be validated by the government. Batch cattle traceability tools such as Selo Verde and Visipec combine GTA and CAR data to link data on cattle movements with properties.

Inherent limitations in using GTA/CAR datasets for cattle traceability include the batch nature of GTA data which means there is an exponential increase in the number of potential supplier farms further up the supply chain (Figure 2) and the increased chance of potential contamination of the supply chain of a non-compliant property. Further limitations include the difficulty with linking GTA and properties due to many GTAs not including CAR, as well as the absence of auxiliary properties from GTA. Furthermore there is a lack of transparency and public availability of GTA and CAR data, especially ownership data.

Estimating cattle supply sheds

Comparing existing approaches to estimate cattle supply sheds in Brazil

A supply shed aims to estimate the full geographic area from which facilities such as slaughterhouses are sourcing commodities, including both direct and indirect supply. We identified and replicated as far as possible four existing approaches to estimate supply sheds in Brazilian cattle supply chains in Pará state: (a) the radius method in which a circle is drawn around each facility using the approach by Alix-Garcia and Gibbs (2017); (b) the logistics method in which a unique shape known as an isochrone is derived around each facility constrained by factors such as travel time along roads or rivers, as used by Imazon and based on their publicly available supply shed shapefiles (Barreto, 2023); (c) the aggregated property method based on creating zones constrained by distance around the locations of known supplier farms/concessions by linking cattle transport records with property data, assuming that unknown suppliers are likely to be located near known suppliers (Brandao Jr, 2023)[1]; (d) the municipality-weighted method which aggregates sourcing regions at the municipality scale. Rather than assuming that sourcing is uniform across the supply shed, it weights supply so that some municipalities, typically closer to the slaughterhouse, supply more cattle than others (zu Ermgassen, 2020).

1. Data limitations for replicating this method include access to animal movement records and adapting spatial autocorrelation methods for use in Python rather than GIS software.

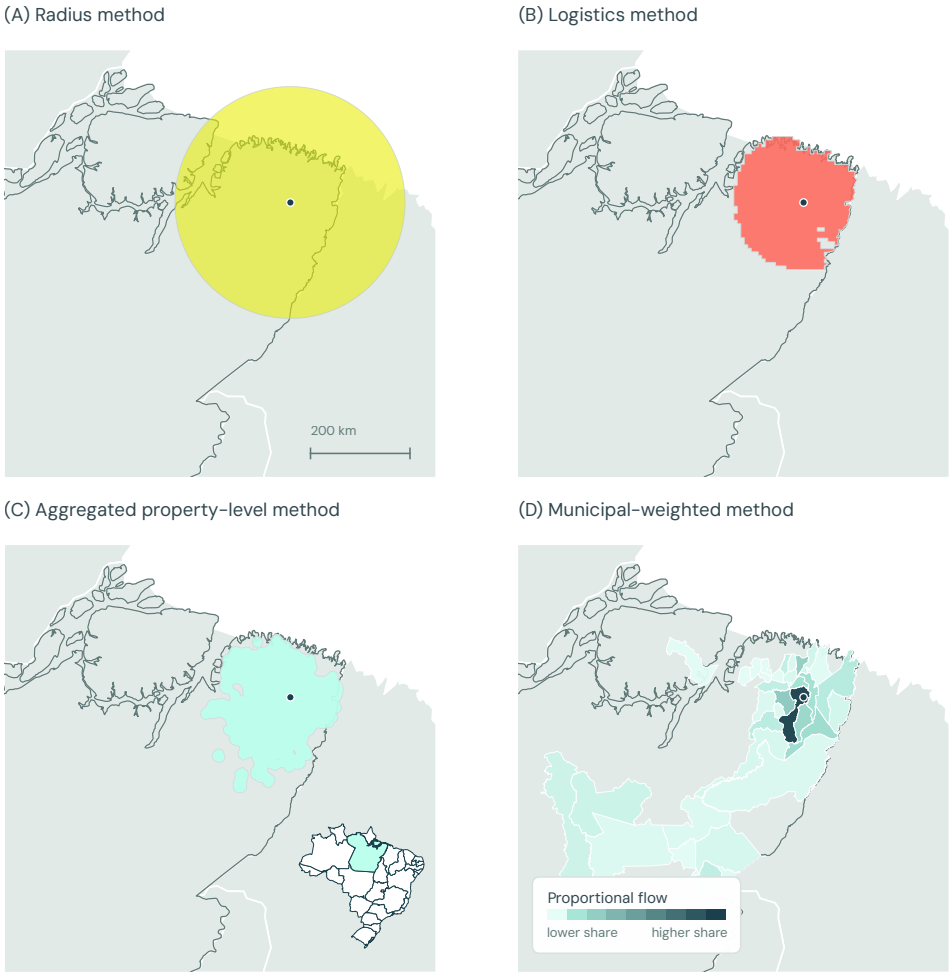

Figure 4: Example supply sheds of a slaughterhouse facility in the municipality of Capitão Poço in the state of Pará generated using four different methods to estimate supply sheds. Each panel shows the geographic extent and shape of the supply shed produced by the corresponding method. In the municipality-weighted panel, the colour gradient represents the proportion of cattle flows originating from each municipality.

A comparison of these four methods in Pará state shows that the size and shape of the logistics-based supply sheds differ markedly between the different methods (Figure 4). The median supply shed of facilities was 24.26 million hectares (Mha) for the aggregated property method, 17.35 Mha for the radius method (this is the same for all facilities), 13.8 Mha for the logistics method and 1.37 Mha for the municipality-weighted method. The municipality-weighted method gives the smallest estimates of the size and associated deforestation exposure of supply sheds, as the area is proportional to the sourcing coming from each municipality.

The circular radius, despite its widespread use in estimating supply sheds, correlates poorly with all three of the data-driven methods that utilise logistical data such as animal movement data, road networks and the location of known supplier properties in different ways to map supply sheds. This is because the radius method is blind to geographical features such as coastlines, rivers and protected areas which modulate sourcing patterns. However, the limited public availability of logistics data is a barrier to widespread use of methods based on it. These constraints result in a high level of variability in the application of different methods in different regions and initiatives.

Methodology

Applying a municipality-weighted approach to estimate cattle supply sheds

We applied the municipality-weighted approach developed by Trase and Do Pasto ao Prato to map the export and domestic market of Brazilian cattle supply chains (zu Ermgassen et al., 2020) to estimate cattle supply sheds for 1,249 of the 1,298 Brazilian slaughterhouses identified by Trase (Pacheco, T. et al 2026b). The supply sheds are weighted with the result that some municipalities, typically near a slaughterhouse, supply more cattle than other, more distant, municipalities (Figure 5). These weightings are based on the origin and number of cattle purchased by the slaughterhouse. We use two different methods to calculate the supply sheds based on data availability.

"The supply sheds are weighted with the result that some municipalities, typically near a slaughterhouse, supply more cattle than other, more distant, municipalities"

1. **Cattle movement records (GTA):** Cattle movement records (GTA) are loaded into a graph database and traversal searches are conducted to trace the movement of cattle across properties. The resulting network captures not only direct suppliers, but also indirect suppliers. Once the network of GTAs is constructed, it is transformed into liveweight movements (carcass tonnes) using conversion factors for cattle of different ages. Input-output methods were used to identify how much of each slaughterhouse's supply originated from each municipality. This slaughterhouse-specific method was used for 600 slaughterhouses that were connected to GTA.
2. **Sanitary certificates data (SIF):** Where GTA data was not available for a given slaughterhouse, we used SIF (*Serviço de Inspeção Federal*) data on the municipality of origin, which is available for export-approved slaughterhouses per state (MAPA). We converted the number of cattle heads into liveweights and calculated the proportion of SIF slaughter per state which originated in each municipality. We apply this supply shed to all slaughterhouses in the state where GTA data is not available, including non-SIF slaughterhouses, so they all have the same sourcing profile. This data is based on direct suppliers. This slaughterhouse specific method was used for an additional 649 slaughterhouses.

We estimated deforestation exposure in the supply sheds of each slaughterhouse in two steps.

1. We assessed the area of recent cattle deforestation in municipalities according to the Trase method, which connects deforestation associated with pasture expansion to cattle production through an assumed five-year lifecycle from birth to slaughter. Pasture deforestation is first identified by overlapping pasture maps with maps of deforestation. Cattle deforestation is then estimated as the average pasture deforestation over the five-year cattle lifecycle. For each municipality, we calculated deforestation intensity as cattle deforestation divided by cattle production in carcass-weight tonnes, producing a municipality-level indicator in hectares per tonne of cattle produced. The same logic was applied to estimate gross greenhouse gas emissions (CO_2-eq) from cattle deforestation per tonne of cattle produced (Trase, 2025).

2. We linked these municipality-level indicators to each slaughterhouse supply shed. For each supplied facility, source municipalities were weighted by their proportional contribution to the total supplied volume. Because GTA and SIF represent the supplied volume across different years, due to gaps in the data the supplied volume is not an accurate representation of the quantity slaughtered per slaughterhouse in a single year. Therefore, we used an index directly related to slaughtered volume for each facility, which is defined by the volume slaughtered by a given facility divided by the median volume across all 1,249 facilities. The resulting deforestation and emissions exposure are expressed as indexes that combine deforestation or emissions intensity, the municipalities' proportional volume contribution to a given facility, and the slaughtered volume index of each facility. These exposure indexes enable a comparison of the relative exposure across supplying municipalities and across slaughterhouses, which can be useful for prioritising engagement, but the values should not be interpreted as deforested area in hectares or gross CO_2-eq emissions in tonnes for a given year. The equations and assumptions are discussed in more detail in the methods document (Pereira, O., 2026).

Going beyond deforestation risks

Our analysis and dataset are focused on deforestation exposure as a major concern in the cattle supply chain. However, the cattle supply chain is associated with multiple social and environmental risks including forced labour, land conflicts and water scarcity. Trase's supply sheds dataset can be used to assess other social and environmental risks where municipality-level geospatial data is available in each sourcing municipality. This data can also support wider assessments of nature risks and opportunities such as water scarcity as set out under the Taskforce for Nature-related Financial Disclosures.

Key findings and ways to use the analysis

Across all 1,249 slaughterhouses, the median number of municipalities that a facility sources cattle from is 123. However, the amount of cattle supplied is highly concentrated in a much smaller number of nearby municipalities. The median number of municipalities that account for 50% of supplied cattle is only eight, while for 75% of supply it is 18 municipalities and for 90% it is 32. This pattern is similar for both SIF (export licensed) and state or municipal licensed facilities (*Serviço de Inspeção Estadual, SIE; Serviço de Inspeção Municipal, SIM*).

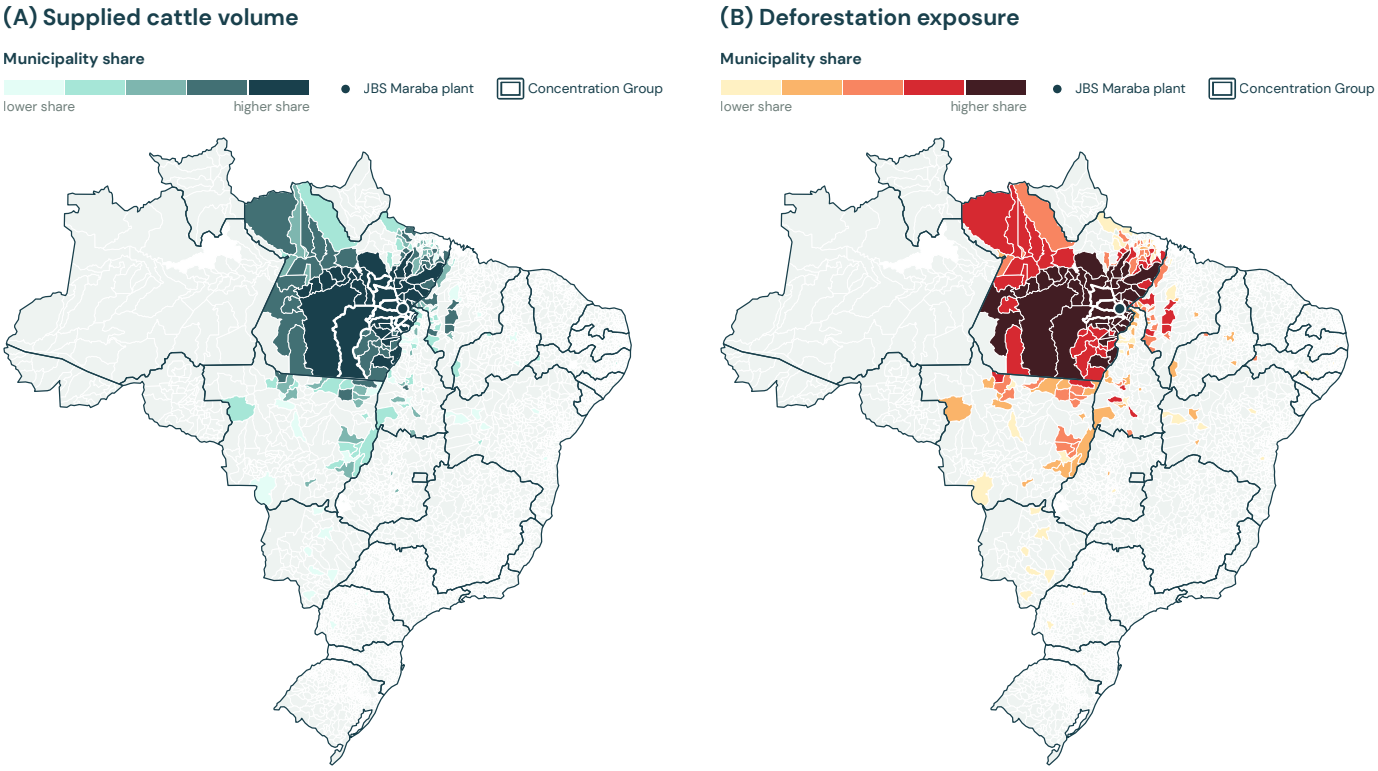

Figure 5: Cattle suppliers to JBS plant in Marabá/PA. The JBS facility sources from 211 municipalities. 76.9% of supplied volume is concentrated in nine municipalities and 91.2% of deforestation exposure is concentrated in three municipalities (1.4% of source municipalities).

Cattle deforestation exposure associated with slaughterhouses based on their supply shed varies widely. The majority of slaughterhouses have very low exposure to cattle deforestation: 1,023 out of the total number of 1,249 slaughterhouses account for less than 4% of total cattle deforestation. In contrast, the top 128 facilities most exposed to cattle deforestation account for 90% of the deforestation exposure, and the top 56 facilities account for 75% of the cattle deforestation exposure (Figure 6).

These results show that although slaughterhouse supply sheds can span large numbers of municipalities, both cattle supply and cattle deforestation exposure are concentrated in a relatively small subset of source municipalities, and a similarly small subset of slaughterhouses have high exposure to cattle deforestation. This concentration creates opportunities for more targeted monitoring, engagement and risk mitigation focused on the municipalities that contribute most to supplied volume and exposure, and the slaughterhouses that source from these areas.

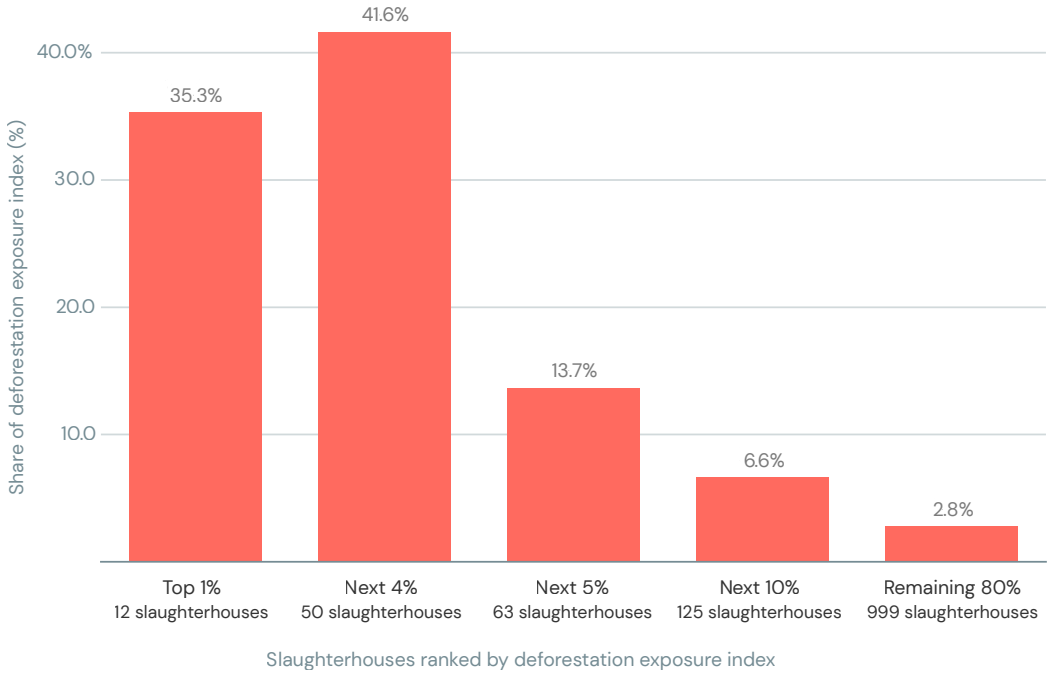

Figure 6: Deforestation exposure is concentrated in a small subset of slaughterhouses

Of the top 128 facilities that account for 90% of the cattle deforestation exposure, 62 are in the Amazon biome. In the Legal Amazon, 108 slaughterhouses have signed TAC agreements with the Federal Public Prosecutor's Office (MPF) to not purchase cattle from properties with illegal deforestation or slave labour within the Legal Amazon. These agreements are audited via the signatories conducting third-party audits and automatic audits by MPF.

We were able to match information on TAC signatory slaughterhouses commitments and audits from sustainability initiative Beef on Track (*Boi na Linha*) to 77 slaughterhouses in the Legal Amazon, despite the audit data being incomplete. While TAC monitoring is currently limited to direct suppliers, this is being expanded to indirect, and is an important indicator of risk mitigation activities that can support company and financial institution engagement with slaughterhouses.

Case study

Using the data to risk benchmark slaughterhouses

Open data on slaughterhouse supply sheds and associated environmental and social risks is important to downstream companies and financial institutions who have less visibility and access to GTA/CAR traceability data.

This anonymised case study showcases how a major consumer goods company is already using Trase's supply shed data to assess its sourcing risks, including scope 3 emissions, for the 23 slaughterhouses it identified in Brazil as direct suppliers as part of its efforts to implement its deforestation and conversion-free policy. The goal was to benchmark and classify the deforestation risk of each slaughterhouse based on its estimated supply shed, using a data-driven approach that goes beyond using a simple radius around the slaughterhouses. We used an adapted version of the open dataset that used estimated slaughter volumes to enable an assessment of absolute cattle deforestation and associated emissions exposure.

In consultation with the company, we assessed the risk of each slaughterhouse based on its sourcing patterns. Slaughterhouses were classified as at-risk if at least 50% of its sourcing volumes came from municipalities classified as high risk of cattle deforestation. High-risk municipalities were defined as those responsible for the majority of cattle-related deforestation in Brazil, accounting for 95% of the median annual deforestation linked to cattle production between 2020 and 2024.

"The results show that cattle deforestation exposure is not uniformly distributed across slaughterhouses"

The results show that cattle deforestation exposure is not uniformly distributed across slaughterhouses: 12 slaughterhouses are classified as at-risk, while 11 are currently not at-risk. Five of the 12 at-risk slaughterhouses account for 67.8% of deforestation exposure. Again sourcing volumes and associated cattle deforestation exposure are highly concentrated across the supply base. According to our analysis (Figure 7), 23 slaughterhouses sourced beef from 1,148 active source municipalities, but just 107 of these municipalities account for 90% of cattle deforestation exposure. The data also identifies slaughterhouses that are TAC signatories and their top-level audit results as publicly available evidence of risk mitigation policies.

This analysis provides the company with evidence to undertake a risk-based due diligence process and enables the prioritisation of engagement with higher risk direct suppliers to assess their risk mitigation strategies. This includes evidence of farm-level traceability, particularly in high-risk municipalities, compliance monitoring systems and controls.

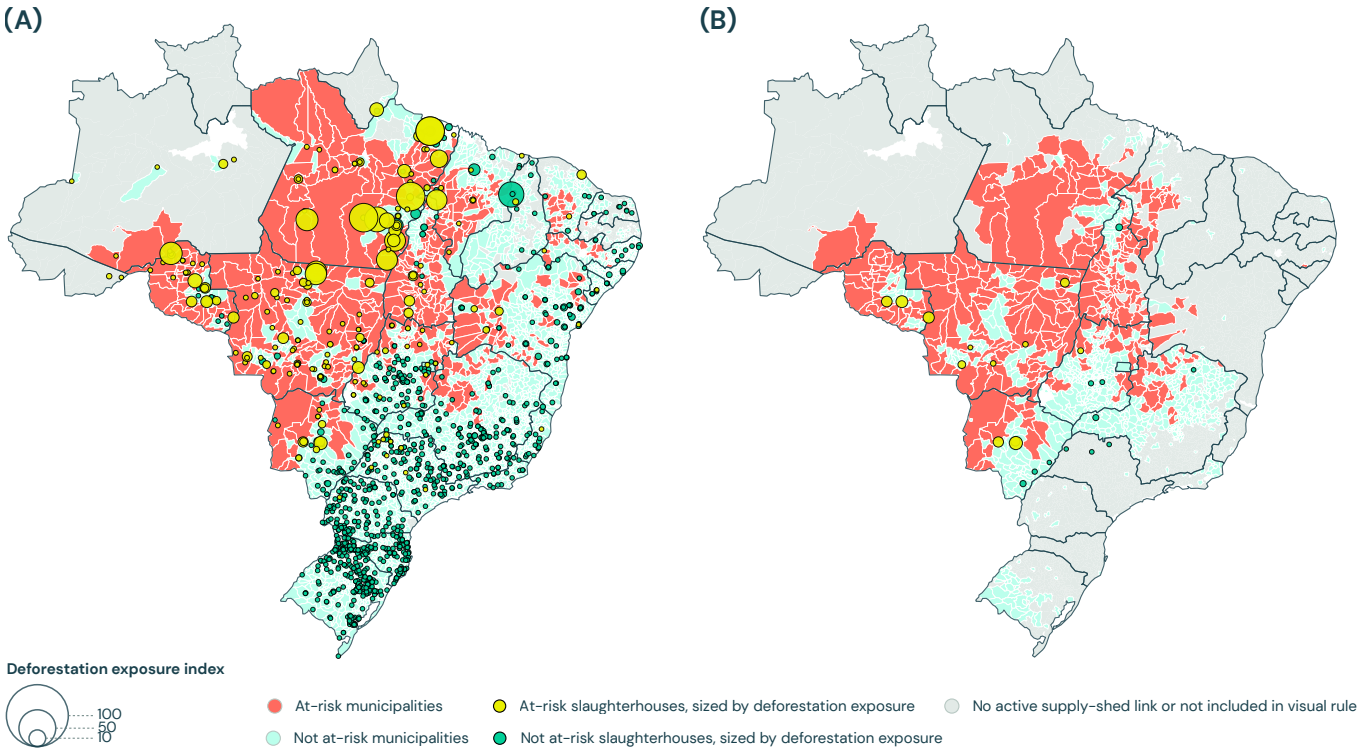

Figure 7: Maps showing the supply shed deforestation risk for all slaughterhouses in Brazil (A) and for the 23 slaughterhouses (B) of our anonymised study.

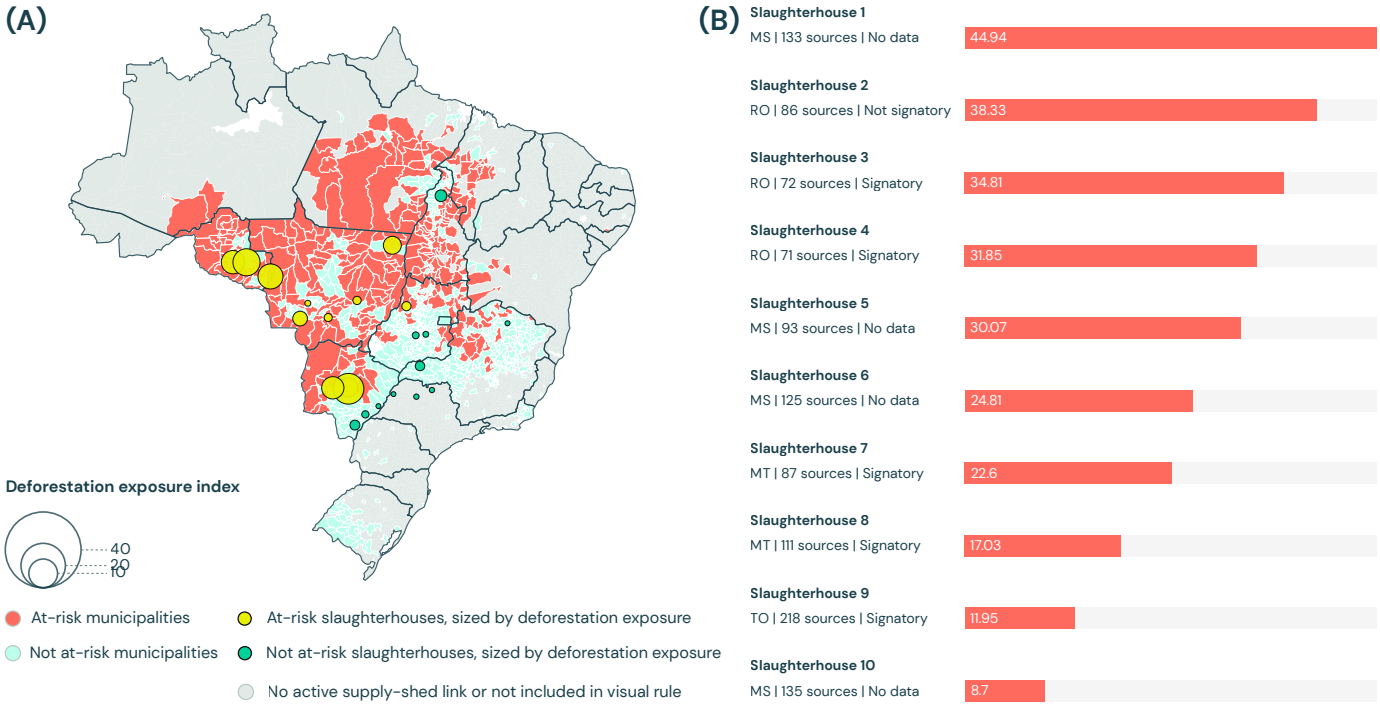

Figure 8: (A) 23 slaughterhouses evaluated in this study requested by the company; (B) top 10 anonymised slaughterhouses by estimated deforestation exposure out of the 23 analysed slaughterhouses. The figure also shows if the slaughterhouse is a TAC signatory.

Recommendations

Supply sheds as a critical tool for risk management and addressing shared risks in cattle supply chains

Open data on facility supply sheds provides an important risk assessment tool for buyers and financial institutions where there are gaps in plot-level traceability data as exemplified in the case of Brazilian cattle. Our review of existing methods to assess cattle supply sheds in the Brazilian Amazon highlights the value of using logistics data to define sourcing areas over a simple radius and the value of a municipality-weighted approach to prioritise sourcing regions. Our new dataset of cattle supply sheds across Brazil shows that deforestation exposure is concentrated both in a small subset of slaughterhouses and for individual slaughterhouses within a small subset of municipalities within its supply shed.

"Our review of existing methods to assess cattle supply sheds in the Brazilian Amazon highlights the value of using logistics data to define sourcing areas over a simple radius and the value of a municipality-weighted approach to prioritise sourcing regions."

In the context of growing demand for supply chain facility-level risk assessment data as well as plot-level traceability systems, Trase has the following recommendations:

1. **Governments need to invest in improving the quality and availability of existing traceability data.** In the case of Brazilian cattle, this includes investing in a national GTA/CAR batch traceability system for cattle that builds on existing datasets and tools (e.g. state-level traceability platforms such as SeloVerde) and prioritises improvements in data quality and transparency to improve connections between GTA and CAR. This can help make the most of these existing datasets while the government invests in an individual cattle traceability and socio-environmental monitoring system over the coming decade.
2. **Companies and financial institutions can use supply shed data as a risk assessment tool** where traceability data is not available and in cases where it has gaps or limits, as is the case currently for Brazil cattle. Approaches that utilise logistics data are more accurate than estimating simple circular sourcing zones around facilities. Methods that weight sourcing volumes within supply sheds (often to regions close to facilities) rather than assuming uniform sourcing can help companies and financial institutions prioritise sourcing regions that provide high volumes and are exposed to higher risks.
3. **Improved coordination among standard-setters is needed to provide aligned best-practice guidance on data-driven methods** to estimate facility supply sheds and associated social and environmental impacts and dependencies that go beyond circular sourcing zone (radius method) approaches. Standards also need to encourage corporate disclosure and risk assessment using these methods where there are gaps in farm-level traceability.

4. **Identify opportunities to address shared risks and share costs.** The fact that the majority of deforestation occurs in areas outside the reach of current GTA/CAR data, combined with the complexity inherent in the highly connected network of slaughterhouse suppliers, underscores the clear business case for landscape-scale investments in farmer compliance, and social and environmental monitoring systems. Where risks are inherently shared across the network of suppliers (especially in the absence of individual traceability and monitoring systems), pre-competitive investment in supporting and incentivising legal compliance by producers can reduce risks across the supply sheds, thereby reducing the cost burden for achieving compliance for individual companies. Similarly, leveraging government investments in pasture restoration, governance and monitoring systems can enable sector wide progress.

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Data and methods

The methodology used in this research is available at https://doi.org/10.48650/3HX5-K876

The dataset can be accessed at https://trase.earth/projects/brazil-beef-supply-sheds

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