# The carbon lottery

## Estimating carbon footprints embedded in European imports of Brazilian beef


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# Contents



# Introduction

**This analysis estimates Europe's imported carbon footprints embedded in Brazilian beef. The size of these estimated footprints is closely linked to the level of exposure of imported beef to the risk of deforestation, a main source of carbon emissions in Brazil's meat industry.**

Europe has committed to reduce the impact of its consumption on global forests.[1] Introducing clear regulation requiring market participants to remove deforestation from supply chains (something currently under consideration by both the EU and the UK) is likely to be crucial in achieving this.

Eliminating forest loss is widely recognised as critical in mitigating climate change.[2] Agriculture is the principal driver of deforestation and a major source of global emissions itself.[3] The meat and dairy sectors play a major role, particularly in Brazil, which seeks to benefit from the imminent EU-Mercosur trade agreement.[4]

Deforestation accounts for nearly half of Brazil's total greenhouse gas (GHG) emissions,[5] with agriculture and cattle ranching, activities closely linked to forest loss, accounting for a further quarter.[6]

As Europe embarks on its Green New Deal, while simultaneously negotiating trade deals anticipated to increase imports potentially produced through lower environmental standards, ensuring carbon emissions associated with European consumption are not outsourced to other countries will be critical.

1 DG Environment, European Commission, "EU communication (2019) on stepping up EU action to protect and restore the world's forests, 2019, available at https://ec.europa.eu/environment/forests/eu_comm_2019.htm.

2 International Union for Conservation of Nature, "Forests and Climate Change", Issues Brief, November 2017, available at https://www.iucn.org/sites/dev/files/forests_and_climate_change_issues_brief.pdf.

3 Curtis, P. G. et al (2018), "Classifying drivers of global forest loss", Science, 14 September, Vol. 361, Issue 6407, pp. 1108-1111, available at https://science.sciencemag.org/content/361/6407/1108.

4 Studies have indicated that as much as 80 per cent of deforestation in the Amazon can be attributed to cattle ranching. See Nepstad, D. et al (2008), "Interactions among Amazon land use, forests and climate: prospects for a near-term forest tipping point", Philosophical Transactions B, May 27; 363(1498): 1737–1746, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2373903/.

5 Observatório do Clima, "Impacto da pandemia de Covid-19 nas emissões de gases de efeito estufa no Brasil", Sistema de Estimativas de Emissões de Gases de Efeito Estufa, Nota Técnica, May 2020, available at http://www.observatoriodoclima.eco.br/wp-content/uploads/2020/05/SEEG-OC_Nota_Tecnica_Covid19_Final.pdf.

6 Op. cit. Nepstad et al (2008).

Around 25 per cent of the carbon emissions embedded in products consumed in Europe are emitted abroad,[7] although this "leakage" may be as high as 40 per cent, and may rise if and when Europe's domestic emissions fall.[8]

Using carbon emissions estimates for Brazilian beef production recently provided by sustainability research organisation Instituto Escolhas, this briefing presents estimates of carbon footprints associated with European imports of Brazilian beef. The study focusses on shipments from the five main Brazilian states of export to the five biggest European countries of import in 2019, covering 88 per cent of the total weight of Brazil-Europe beef trade.

The carbon intensity of Brazilian beef imported by Europe depends on a range of factors, most importantly whether pasture is located on recently deforested land. Other important factors include the biome and type of pasture where cattle were raised and fattened.

## "Around 25 per cent of carbon emissions embedded in products consumed in Europe are emitted abroad"

Nine of the top 10 European importing companies contacted for this analysis chose not to provide information on their sourcing practices or embedded carbon footprints, indicate whether their suppliers were mapping the origins of the cattle they slaughter, or whether deforestation was involved.

In the absence of such information, this analysis compares the range of sourcing scenarios available, within which the carbon footprints are estimated to lie.

This briefing comes at a time of heightened concerns over Brazil's increasing deforestation levels and its role in global climate change.

The Covid-19 pandemic is likely to result in a global drop in carbon emissions this year, yet Brazil is set to contradict the trend due to rising forest loss.[9]

This paper highlights the need for vigilance when it comes to sourcing agri-commodities from a country in the midst of one of its worst environmental crises.

7 Sam Lowe, "Should the EU tax imported CO2?", Centre for European Reform, September 2019, available at https://www.cer.eu/sites/default/files/insight_SL_24.9_19.pdf.

8 IDH, The Sustainable Trade Initiative, "Hidden CO2 emissions: Europe's imported responsibility", 14 February 2020, available at https://www.idhsustainabletrade.com/news/hidden-CO2-emissions-europes-imported-responsibility/.

9 Op. cit. Observatório do Clima (2020).

# Summary of findings

**The analysis highlights some key findings:**

- Deforestation is a major contributing factor to the carbon emissions of beef production in Brazil. Whether or not pasture where cattle are reared and fattened sits on deforested land significantly influences emissions embedded in beef production in Brazil. This is reflected in estimated carbon footprints embedded in European imports of Brazilian beef. Importers more exposed to sources of beef that are in turn linked to a high level of risk of deforestation (for example, beef originating from the Amazon and Cerrado state of Mato Grosso) have higher estimated embedded carbon footprints.
- As a result, the states from which Brazilian slaughterhouses export (when assumed to correspond with the state of beef production) dramatically influence the levels of Brazilian carbon emissions embedded in European beef imports, and significantly more so than the weight of imports. This applies to both recipient countries and importing companies.
- Rankings of volumes of imports into European countries or by individual companies do not reflect rankings of estimated embedded $CO_2e$ emissions.
- Using *state-level* average emissions estimates, the countries consuming the highest amounts of embedded emissions are: Italy (244,440 to 1.1 million $tCO_2e$); the Netherlands (162,407 to 633,124 $tCO_2e$), Spain (94,208 to 451,298 $tCO_2e$), Germany (63,364 to 224,623 $tCO_2e$) and the UK (50,031 to 152,294 $tCO_2e$). This combined 2.6 million $tCO_2e$ is equivalent to the 2018 carbon emissions of 298,148 Europeans. Exports from Mato Grosso alone account for 2.2 million $tCO_2e$, or 85 per cent of this total carbon footprint.
- If all beef imported into Europe was derived solely from *stable pastures* (low-productivity pastures with no capacity to remove carbon from the atmosphere) in each state, the total upper-average embedded emissions (when deforestation is involved) for the five European countries rise to 4.9 million $tCO_2e$ – nearly double that when applying state-level averages and equivalent to the 2018 carbon emissions of 565,800 Europeans.
- Of the five states dominating supply to the five main countries of import, Mato Grosso provides the most beef overall. Each tonne of beef produced in the state also presents by far the highest exposures to embedded emissions due to high levels of forest loss associated with cattle ranching in the state. Mato Grosso has the highest proportion of beef production linked to *degraded pastures* (low-productivity pastures with inadequate soil management and closely linked to deforestation, resulting in high carbon emissions) – enough to provide 36 per cent of all imports from the state into the five European countries.
- If all beef derived from the slaughter of cattle reared on *degraded pastures* in Mato Grosso were applied to European imports, and the remainder of imports from that state and all other four states were estimated using respective state-level upper-averages, the total carbon footprint embedded in the 88 per cent of European imports of Brazilian beef would be as high as 20.8 million $tCO_2e$.[10] This would be equivalent to the 2018 carbon emissions of 2.4 million Europeans.
- Of all European importers contacted for this study, only Marfrig provided estimates of the carbon emissions embedded in its beef imports, derived from a study by the Getulio Vargas Foundation which estimated carbon footprints ranging from 27kg $CO_2e$/kg beef to 99kg $CO_2e$/kg beef. Applying this range to 2019 imports from the top five Brazilian states of export into the aforementioned five European countries suggests that the carbon emissions embedded in this trade vary between 2.6 million $tCO_2e$ and 9.6 million $tCO_2e$, equivalent to the annual emissions of 305,447 and 1.1 million Europeans.
- Europe's estimated embedded emissions linked to Brazilian beef are dramatically concentrated in the imports of relatively few companies. When considering estimates based on state-level upper-averages, just two firms (Silca and JBS) account for nearly a quarter of estimated emissions, eight firms are responsible for over half, and 27 account for 80 per cent.
- Some European firms have higher embedded carbon footprints – when calculated based on state-level upper-average emissions – than some recipient countries. Italian firm Silca has a higher estimated footprint (375,000 $tCO_2e$) than Germany (224,623 $tCO_2e$) or the UK (152,294 $tCO_2e$). The Brazilian group JBS (221,538 $tCO_2e$), German importer Tonnies Fleisch (199,411 $tCO_2e$), and Italian company Bervini Primo (181,660 $tCO_2e$) also have higher embedded emissions than the UK (though the importance of corned beef in UK imports may have led to its emissions being underestimated).

10 Calculated by multiplying 36 per cent of European imports from Mato Grosso by the carbon footprint for degraded pastures with deforestation, and the remaining 64 per cent using the state level upper-average emissions estimate for Mato Grosso.

# Methodology

**This analysis uses available data to estimate carbon footprints embedded in Brazilian beef imported into Europe between January and December 2019. It also identifies those European countries and companies presenting the biggest risk of high carbon footprint exposure.**

## Data collection and generation

Two core data sets form the basis of the analysis: 1) Brazilian beef product export records, and 2) data on carbon emissions from beef production in Brazil, either provided by Instituto Escolhas or available in their study on the environmental impacts of the beef industry in Brazil (see annex 4 for more information on the study).[11]

### *Trade data collection*

Trade data of all Brazilian beef exports to a list of 30 European countries (the 27 members of the European Union, plus the United Kingdom, Switzerland and Norway) was obtained for 2019.[12] All shipment data were accessed in weight (kgs) and converted to tonnes (1000kg).

A combination of four-digit and six-digit HS customs codes was used to obtain shipment records capturing a comprehensive range of beef products in the trade data.[13]

### *Brazilian beef carbon footprint data collection*

Instituto Escolhas' study is one of the first to calculate carbon footprint figures for beef production in every Brazilian state, including for the Amazon and Matopiba (an area of the Cerrado biome).

The study provided carbon footprint estimates in *kilograms of carbon dioxide equivalent per kilogram of beef* (**kg$CO_2$e per kg of beef**) for each of **five types of herd management systems**: degraded, stable, and well managed pastures, integrated, and confinement systems.

### HERD MANAGEMENT SYSTEMS

Instituto Escolhas quantified the carbon intensity of beef "production" under five different herd management systems, with widely differing carbon footprints. The management systems are:

**Degraded pastures:** characterised by low technology and inadequate soil management, resulting in productivity lower than 0.75 cows per hectare. This kind of pasture is a high carbon emitter mainly due to processes associated with soil degradation. It is also a kind of pasture more commonly found in recently deforested areas. Deforestation accounts for as much as 85 per cent of the total carbon footprint of beef produced from cattle reared in degraded pastures in the Amazon. Degraded pastures' low productivity pushes ranchers to clear further forested areas for new pastures.

**Stable pastures:** also referred to as vulnerable pastures, they have similar characteristics as degraded pastures and can become degraded pastures within a year if not well managed. Herd capacity is between 0.75 and 1.5 cows per hectare. This kind of pasture is classified as a stable GHG emitter (it does not emit or remove carbon from the atmosphere).

**Well managed pastures:** characterised by high technology and good soil management, increasing soil performance and productivity. Herd capacity is greater than 1.5 cows per hectare. This kind of pasture is classified as a carbon sink due to soil preservation.

**Integrated systems:** combine cattle ranching with agricultural and forest production within the same area. All activities are mutually beneficial. Land use is maximised, increasing productivity. This kind of system is also a carbon sink due to soil preservation.

**Confinement:** herds are enclosed in corrals or within fences. Feed and water are provided in troughs. Confinement is most commonly used for fattening cows from integrated systems or well managed pastures in the three months of their lives before slaughter.

11 Instituto Escolhas, "Do Pasto ao Prato: Subsídios e pegada ambiental da carne bovina", 30 January 2020, available at http://www.escolhas.org/wp-content/uploads/2020/01/Relatorio_Do-pasto-ao-prato_Pegadas_FINAL.pdf.

12 Data obtained through Panjiva. The data were compared with Comex Stat data on Brazilian exports provided by Brazil's Ministry of the Economy and with international import and export data provided by UN Comtrade. Despite some discrepancies between the different data sets, the use of Panjiva data was chosen due to the availability of volumes imported by individual European firms and the possibility of selecting six-digit HS codes for beef products. Similar studies that use Comex Stat, UN Comtrade or other data sets will have slightly different results than the ones presented here.

13 HS codes used: 0201 (Fresh or chilled bovine meat); 0202 (Frozen bovine meat; 020610 (Fresh or chilled edible offal of bovine animals); 020621 (Frozen edible bovine tongues); 020622 (Frozen edible bovine livers); 020629 (Frozen edible bovine offal, excluding tongues and livers); 160250 (Prepared or preserved meat or offal of bovine animals).

They also calculated "**kg$CO_2$e per kg of beef**" values for each of these three variables (geographic, biome type, and herd management type) – all **with** *and* **without deforestation** factored in.

On request, Instituto Escolhas researchers kindly calculated averages for each individual state (again, with or without deforestation), and shared slaughter rates per management system for this analysis.

### *Data generation*

Carbon emissions footprints for traded beef were estimated for **each European country** and **each company operating in Europe**.

These were obtained by multiplying the kilos of beef products imported into each European country and company by the average of the ten-year (2008-2017) kg$CO_2$e/kg beef values provided by Instituto Escolhas for each different herd management and pasture type in each Brazilian state.

Each shipment was attributed to a given Brazilian state using the address of the exporting slaughterhouse/facility named in shipment records.

This allowed the production of figures expressing imports of Brazilian beef in **tonnes of $CO_2$e (t$CO_2$e)** for the January – December 2019 period across the range of variables detailed in the Instituto Escolhas data and the range of Brazilian states of export indicated by the trade data.

Questions were sent to the 10 companies importing the highest volumes of beef into Europe, and several others of note, to elicit information on company due diligence on actual herd management and pasture types underpinning their Brazilian imports. Only Marfrig chose to respond and provide estimated carbon footprints for its beef imports into Europe. These are discussed alongside this study's analysis of importers' embedded emissions.

## Data analysis

Seventeen of the 30 European countries screened (15 EU members, plus the UK and Norway) imported beef from Brazil in the period. Of these, just five European countries accounted for 92 per cent of European imports. These were Italy (29 per cent), the United Kingdom (25 per cent), the Netherlands (21 per cent), Spain (9 per cent) and Germany (8 per cent).

On the Brazilian side of the supply chain, five exporting states – São Paulo, Mato Grosso, Rio Grande do Sul, Goiás, and Mato Grosso do Sul – accounted for 96 per cent of all exports to Europe.

The analysis was focussed only on trade between slaughterhouses in these five Brazilian states and companies importing into the aforementioned five European countries, the combination of which covers 88 per cent of Brazil-Europe beef trade in 2019.

A range of scenarios employing GHG emissions averages associated with the different herd management and pasture types defined by Instituto Escolhas were analysed. Only scenarios where slaughter rates were sufficient to meet European demand were considered.

These included: 1) estimates applying the Brazilian's *national averages* to all imports; 2) estimates where all imports were assessed using *state-level averages*; 3) estimates where all imports derived from *stable pastures*; and 4) estimates where all beef derived from the slaughter of cattle reared on *degraded pastures* in Mato Grosso were applied to part of European imports and the remainder of imports from that state and all other four states were estimated using respective state-level averages.

While the analysis has relied on the findings of Instituto Escolhas' study, any error or omission are the sole responsibility of Earthsight. While Instituto Escolhas was kind enough to support this analysis by providing the data highlighted above, it did not in any way sponsor, direct, or otherwise participate in this study.

## Limits of the data and the study

The study presents estimated rather than precise carbon footprints due to limits to the available data. It can only estimate the carbon footprints of any one recipient country or importing company, because it cannot make concrete conclusions on the actual carbon footprints of any one beef exporting slaughterhouse in Brazil.

The Instituto Escolhas data do not assess the actual carbon emissions of any specific slaughterhouse exporting to Europe – instead estimating emissions by state, production method, and other variables. Critically, the specifics of which ranches supply which slaughterhouses supplying Europe, and how these ranches and associated pastures are managed, is not catered for in Instituto Escolhas' study.

While exporting slaughterhouses' addresses provide information about the state from which the processed beef was exported, it does not tell us where the cows were reared/fattened during their life cycles. A large share would certainly come from the states where the slaughterhouses are based. But a smaller proportion would undoubtedly be brought from different states to be

slaughtered in the exporting facilities or would have spent at least part of their lives in other states.

Issues such as the long-distances a minority of cattle can be transported before arriving at an exporting slaughterhouse, the absence of information on indirect suppliers in slaughterhouse supply chains, the trade between slaughterhouses based in different states, and other important traceability factors are not studied in detail in the Instituto Escolhas' study, and these limits carry over into this analysis.

Several of the carbon footprints of European beef imports from Brazil presented here could be considered conservative estimates. Those for imports coming from slaughterhouses in São Paulo, Mato Grosso do Sul, Goiás and Mato Grosso could be underestimating carbon emissions because a percentage of the cows slaughtered in these facilities may come from neighbouring states with higher footprints than the state of export. For example, Mato Grosso do Sul and Goiás are probably sources of cattle for slaughterhouses in São Paulo; Mato Grosso for slaughterhouses in Mato Grosso do Sul and Goiás; Pará and Rondônia for slaughterhouses in Mato Grosso.

Furthermore, it is known that slaughterhouses which export highly processed beef – such as corned beef and other types of canned meat – source part of their fresh beef from other slaughterhouses, which may in some cases be located in other states. A southern-based meatpacker exporting corned beef may be purchasing fresh beef from slaughterhouses based in states further north that are more likely to source cattle from ranches in the Amazon or Cerrado biomes where deforestation is more common and carbon footprints are higher.

The likelihood that carbon footprints presented in this study are conservative estimates is reinforced by the embedded carbon emissions estimates provided for this analysis by Marfrig, a firm that both exports beef from Brazil and imports it into Europe. These are derived from a study published in October 2019 by the Getulio Vargas Foundation (GVF) that focussed specifically on the embedded carbon footprints of Brazilian beef exported to the European Union.[14]

The GVF study uses similar methodologies to those applied by Instituto Escolhas, but is much more limited in scope

14 Centro de Estudos em Sustentabilidade (FGVces) da Fundação Getulio Vargas (FGV EAESP), "Pegada de carbono da carne bovina brasileira exportada para a União Europeia", October 2019, available at http://mediadrawer.gvces.com.br/publicacoes-2/original/pccbb_sumario-executivo_27nov.pdf.

as it only analysed a sample of 23 farms based in Mato Grosso, São Paulo, Goiás, Minas Gerais and Mato Grosso do Sul to calculate the carbon footprints of beef exported to the EU.[15] Its estimates of emissions embedded in Brazilian beef entering the EU range from 27 to 99kg $CO_2$e/kg beef. Applying this range to Marfrig's trade data reveals emissions several times higher than those estimated using Instituto Escolhas' carbon footprints.

Further, applying specific herd management or pasture-type carbon emission estimates to exports from a given state can dramatically increase or decrease estimates of imported emissions. This suggests it may be statistically *fairer* to only use state-level averages when making imported emissions estimates, as doing so spreads trade volumes across the range of pasture and herd management types that occur in Brazil.

However, to apply state-level averages to trade also assumes European companies import beef in direct proportion to the slaughter volumes across herd management/pasture types across the key supply states – an assumption which is not known to be true or otherwise.

No one knows the actual spread of herd management/pasture types used for the specific cattle producing beef subsequently imported into Europe. Brazil's Sisbov system requires that all beef exports to Europe are produced from tagged cows registered on the TRACE List, making it technically feasible to know every farm supplying beef ultimately exported to Europe.[16]

However, Sisbov is a sanitary inspection system geared towards health and safety, does not necessarily cover all farms in which cattle are reared, and does not involve monitoring or collation of information on management or pasture types, or whether deforestation is involved in pasture development.[17]

It is far from clear whether individual exporting meatpackers are using Sisbov farm data to monitor deforestation or emissions linked to supplying farms. The lack of responses from almost all top 10 Europe-based importing companies – except Marfrig – regarding information available to them from their suppliers suggests a structural limit to data availability at this time. Corroborating this is the fact that many major exporting meatpackers in Brazil have consistently highlighted the absence of systems to trace indirect suppliers of the cattle they slaughter.

Finally, it is important to note that Instituto Escolhas' analysis covers the decade between 2008 and 2017 – when deforestation was generally decreasing. This trade data analysis covers 2019. This discrepancy is particularly relevant for the deforestation factor in the carbon intensity of beef production in Brazil. As the years since 2017 have seen continuous increases in deforestation (including by as much as 30 per cent in 2019), the calculations of the carbon footprint of European imports of Brazilian beef for the 2019 period could be an underestimate.

These limitations should not invalidate the present study. The application of the Instituto Escolhas study to real-world trade data does allow for a valid discussion on where carbon intensity risk lies in the Brazil-EU supply chain that might form the basis for further research and/or due diligence going forward – or at least highlight the need for it.

15 See the study for more details. Marfrig, along with other top Brazilian meatpackers JBS and Minerva, supported the publication of this study. In its reply to Earthsight, Marfrig stated that the company "collaborated with the [Getulio Vargas Foundation] to prepare the report."

16 Brazilian Cattle and Buffalo Traceability System. For more information see http://www.in.gov.br/web/guest/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/44306336/do1-2018-10-08-instrucao-normativa-n-51-de-1-de-outubro-de-2018-44306204 and https://www.agrodefesa.go.gov.br/defesa-sanitaria-animal/sisbov.html.

17 Loopholes in the system allow Sisbov-registered farms to receive animals reared in non-registered farms as long as they subsequently register the animals. See Sisbov sources referenced above.

## DEFORESTATION IN THE CARBON FOOTPRINT OF BRAZILIAN BEEF

Carbon emissions from cattle farming account for the most significant portion of the carbon footprint of beef produced in Brazil.[18]

Emissions from cattle farms have several sources, including the herd itself, soil management, and, crucially, land use change. The conversion of native forests into pastures plays a critical role in carbon emissions associated with Brazilian beef production, with 80 per cent of deforested land used for ranching cattle.[19]

Whether a patch of forest or native vegetation was cleared for pasture determines, to a large extent, the carbon intensity of beef production. Carbon footprint estimates reflect this dynamic.

Instituto Escolhas' study shows that when recent deforestation is involved in pasture development, the average annual carbon footprint of Brazilian beef is 78kg of $CO_2$e per kilo of beef. But if deforestation is not involved this drops to 25kg of $CO_2$e per kilo of beef, a 68 per cent reduction.

Deforestation for pasture plays a larger role where carbon stocks in native forests and vegetation are higher, with the carbon intensity of beef linked to forest loss being most pronounced in the Amazon.

The average carbon footprint of 1kg of beef produced outside the Amazon is 23kg of $CO_2$e if forest loss is accounted for. If deforestation is not considered, the footprint drops to 19kg of $CO_2$e.

But in the Amazon, which has a high carbon stock of 573 $tCO_2$e/ha, the carbon footprint of 1kg of beef is 145kg of $CO_2$e if deforestation is involved, but just 17kg of $CO_2$e where it is not.

The carbon footprint of beef produced from cattle farmed on degraded pastures, which have poor soil management and low productivity, is largely determined by deforestation. In degraded pastures in the Amazon, deforestation accounts for as much as 85 per cent of the total footprint.

Instituto Escolhas concluded that "a reduction in deforestation […] must be addressed as the main priority" to lower the carbon footprint of Brazilian beef.

Low productivity in degraded pastures (no more than 0.75 cows per hectare) is critical as it pushes ranchers to clear further forested areas for new pastures, leading to more GHG emissions.

In light of recent increases in forest loss in the country, the relationship between deforestation and Brazilian beef's high carbon intensity raises concerns about the industry's sustainability.

Brazilian Amazon deforestation has increased every year since 2017, and by 30 per cent in 2019.[20] Clearances in the first six months of 2020 rose by 24 per cent compared to the same period in 2019, reaching 2,544km$^2$, the second largest amount in any semester since 2010.[21]

Of the five main Brazilian states exporting beef to Europe – São Paulo, Mato Grosso, Rio Grande do Sul, Goiás, and Mato Grosso do Sul – Mato Grosso has the highest carbon footprint variability depending on whether or not deforestation is taken into account, dropping 84 per cent from 68kg to 11kg of $CO_2$e per kilo of beef.

It is followed by Goiás and Mato Grosso do Sul – both extensively covered by the Cerrado, a biodiverse biome home to indigenous communities and rare wildlife. Soy farming[22] and cattle ranching – much of it illegal – have already replaced more than half of the Cerrado's 2 million sq km.[23]

Mato Grosso, home to swathes of Amazon and Cerrado land, loses more forest to pasture than any state in Brazil except for Pará. The state lost 1.37 million hectares of Amazon and Cerrado vegetation from 2008 to 2017, accounting for 16 per cent of all conversion to pastures in these biomes.[24] In 2019, Mato Grosso accounted for nearly a fifth of Brazil's total deforestation, losing 202,000ha of forests.[25]

Unsurprisingly, Mato Grosso's GHG emissions from conversion to pasture is also the second highest nationally (557 million $tCO_2$e between 2008 and 2017), accounting for 17 per cent of Brazil's total.

In July 2020 Raoni Rajão and a group of researchers published new research on the links between illegal deforestation in the Amazon and Cerrado and EU imports of Brazil's soy and beef.[26]

18 Unless otherwise referenced, all the data on carbon footprint related to beef production in Brazil highlighted in this section are taken from Instituto Escolhas' study. See Instituto Escolhas, "Do Pasto ao Prato: Subsídios e pegada ambiental da carne bovina", 30 January 2020, available at http://www.escolhas.org/wp-content/uploads/2020/01/Relatorio_Do-pasto-ao-prato_Pegadas_FINAL.pdf

19 Op. cit. Nepstad et al (2008).

20 For monthly deforestation data up to April 2020 see ImazonGeo at https://imazongeo.org.br/#/. For 2019 figures see Mapbiomas, "Relatório Annual do Desmatamento do Brasil – 2019", May 2020, available at http://alerta.mapbiomas.org/relatorios.

21 Imazon, "Desmatamento na Amazônia cresce 24% no primeiro semestre de 2020, aponta sistema de monitoramento do Imazon", 17 July 2020, available at https://imazon.org.br/imprensa/desmatamento-na-amazonia-cresce-24-no-primeiro-semestre-de-2020-aponta-sistema-de-monitoramento-do-imazon/.

22 Earthsight, "Poultry excuses? UK chicken retailers' soy purchases aiding destruction of South American forests", 24 January 2020, available at https://www.earthsight.org.uk/news/idm/UK-chicken-soy-greenpeace-south-america-deforestation-.

23 Stockholm Environment Institute, "Brazilian beef trade's link to deforestation revealed by transparency tool", 18 September 2019, available at https://www.sei.org/about-sei/press-room/brazilian-beef-trades-links-to-deforestation/.

24 Op. cit. Instituto Escolhas (2020).

25 Mapbiomas, "Relatório anual do desmatamento do Brasil – 2019", May 2020, available at http://alerta.mapbiomas.org/relatorios.

26 Rajão, R. et al, "The rotten apples of Brazil's agribusiness", Science, 17 Jul 2020, Vol. 369, Issue 6501, pp. 246-248. Available at https://science.sciencemag.org/content/369/6501/246.

By tracing beef exports from slaughterhouses to the EU, Rajão and his colleagues estimated that around 18,000 metric tonnes of beef exported from Mato Grosso and Pará to the EU in 2017 (nearly half of the total) may have been linked to illegal deforestation (via both direct and indirect suppliers).

The authors found that beef linked to cattle reared in Mato Grosso – when considering direct and indirect suppliers – have high rates of contamination by potentially illegal deforestation, amounting to 44 per cent in the Amazon and 61 per cent in the Cerrado.[27]

Supply chains that rely more heavily on Mato Grosso as their source of Brazilian beef are therefore more exposed to higher carbon footprints, as the analysis in this report illustrates.

27 See also the study's supplementary materials at https://science.sciencemag.org/content/sci/suppl/2020/07/15/369.6501.246.DC1/aba6646_Rajao_SM.pdf.

# European country analysis

**Five European countries alone received 92 per cent of all European purchases of Brazilian beef during 2019 – Italy, the UK, the Netherlands, Spain, and Germany. Similarly, 96 per cent of imports into Europe were from slaughterhouses located in just five Brazilian states: São Paulo, Mato Grosso, Rio Grande do Sul, Goiás, and Mato Grosso do Sul.**

The 4,896 consignments to these five countries from slaughterhouses in these five Brazilian states amounted to 97,290 tonnes – worth $679 million – and accounted for 88 per cent of all Brazil-Europe beef trade in 2019, and are the focus of this study.

Slaughterhouses in Mato Grosso provided 32,129 tonnes of beef to these five countries – 33 per cent of their imports from the five states.

### *Share of Brazilian beef exports to the top five European countries of destination by state of origin*

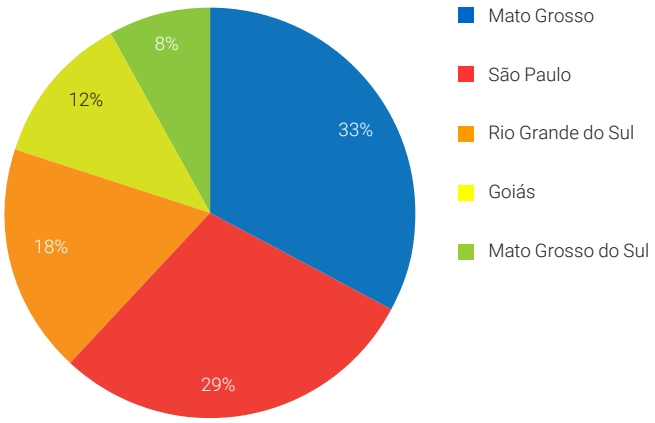


**Figure 1:** *Share of beef exports to Italy, the UK, the Netherlands, Spain and Germany combined from each of the top five Brazilian states of export. See table below for the imports in tonnes.*

## European imports of Brazilian beef

### *Brazil national-level emissions averages*

Instituto Escolhas estimated that the national carbon footprint average of Brazilian beef production ranges from 25kg to 78kg of $CO_2e$ per kilo of beef (depending on whether or not deforestation is factored in).

Applying these national averages to exports from slaughterhouses in the five states to the top European countries suggests this trade embedded between 2.4 million tonnes and 7.6 million tonnes of Brazilian carbon dioxide equivalent ($tCO_2e$) emissions.

The national ranking and breakdown in Europe would be: Italy (741,245 to 2.3 million $tCO_2e$); the UK (700,761 to 2.2 million $tCO_2e$); the Netherlands (552,105 to 1.7 million $tCO_2e$); Spain (236,639 to 738,312 $tCO_2e$); Germany (201,512 to 628,717 $tCO_2e$).

However, with most trade concentrated on slaughterhouses in just five states, the Brazilian national average carbon footprint does not really apply, and a more nuanced analysis shows how the carbon footprint of imports into European countries can be significantly higher or lower depending on the Brazilian state in which the cattle are produced.

### *State-level emissions averages*

Applying Brazilian state-level emissions averages – rather than Brazil's national average – to European imports reveals that trade volume rankings by European country (or company) of import are not always mirrored in carbon footprint rankings.

The top five European country recipients of beef from the five aforementioned states in Brazil – Italy (29,650 tonnes), the UK (28,030 tonnes), the Netherlands (22,084

| | Top five countries by top five states, 2019 (tonnes) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Mato Grosso (MT) | São Paulo | Rio Grande do Sul | Goiás | Mato Grosso do Sul | Total imports | % imports from MT |
| **Italy** | 14,278.75 | 7,683.07 | 242.20 | 4,413.81 | 3,031.95 | 29,649.78 | 48.2 |
| **United Kingdom** | 1,617.00 | 11,096.75 | 13,975.47 | 1,213.97 | 127.25 | 28,030.44 | 5.8 |
| **Netherlands** | 7,641.44 | 6,366.43 | 2,043.84 | 3,411.61 | 2,620.88 | 22,084.20 | 34.6 |
| **Spain** | 6,033.44 | 1,002.69 | 258.84 | 1,334.54 | 836.03 | 9,465.54 | 63.7 |
| **Germany** | 2,558.34 | 1,973.11 | 908.78 | 1,514.54 | 1,105.71 | 8,060.48 | 31.7 |
| **Total** | **32,128.97** | **28,122.05** | **17,429.13** | **11,888.47** | **7,721.82** | **97,290.44** | **33.0** |

**Table 1:** *Trade data obtained through Panjiva. The column '% imports from MT' shows the proportion of imports from Mato Grosso for each of the five European countries compared to their imports from the top five exporting states in Brazil.*

## *Estimated carbon footprints embedded in European imports of Brazilian beef*

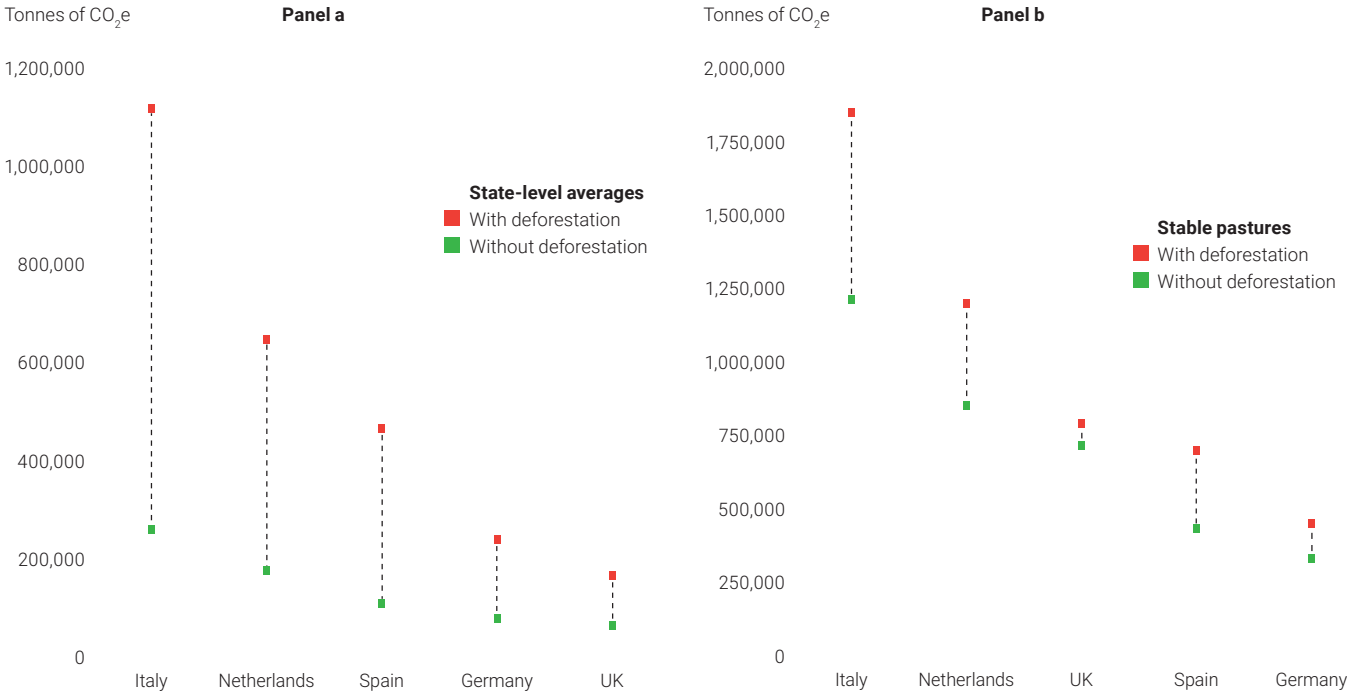


**Figure 2:** *Estimated carbon footprints embedded in beef imports into the top five countries of import from the top five Brazilian states of export. Panel a shows footprints derived from state-level emissions ranges, while panel b shows footprints if all imports were linked to stable pastures only. Country ranks change in each panel, with neither reflecting rank by trade volume. See annex 1 for the detailed data.*

tonnes), Spain (9,466 tonnes), and Germany (8,060 tonnes) – do not rank in the same order when assessing the carbon emissions these imports may have produced in Brazil.

Imports into Italy had the highest average embedded carbon footprint – without or with deforestation – ranging from 244,440 to 1.1 million $tCO_2e$. Italy is followed by the Netherlands (162,407 to 633,124 $tCO_2e$), Spain (94,208 to 451,298 $tCO_2e$), Germany (63,364 to 224,623 $tCO_2e$) and the UK (50,031 to 152,294 $tCO_2e$). (See figure 2).

Italy maintains pole position in the embedded emissions of its beef imports using state-level averages not only due to its large import volumes but also – and crucially – due to its reliance on beef from Mato Grosso. Nearly half of all Italian imports (48 per cent, or 14,279 tonnes) come from that state.

As we have seen, of the top five states dominating the supply to Europe, Mato Grosso has the highest carbon footprint estimates, due to high levels of deforestation. Furthermore, when analysing carbon footprints derived from individual herd management systems, the Mato Grosso emissions can be even larger. Specifically, when looking at the carbon impact of cattle reared on degraded pastures, the $CO_2e$ per kilo of beef in Mato Grosso is estimated to be nearly 12 times greater than that of São Paulo, Brazil's largest state of export (see discussion on degraded pastures below).

The Netherlands, the third largest European recipient country by weight, comes second when estimating the carbon emissions embedded in imported Brazilian beef using state-level averages (see annex 1). The country receives more than one-third of its beef from Mato Grosso (7,641 tonnes). Spain, which receives nearly three times less beef than the UK and less than half that imported into the Netherlands, occupies third place in the carbon table due to its overreliance on imports from Mato Grosso. Almost two-thirds of the country's imports come from the state (6,033 tonnes).

Germany, the smallest of the top five European recipient countries, has the second lowest average carbon footprints – largely due to its much smaller import volumes. Nonetheless, Mato Grosso, Goiás and Mato Grosso do Sul, the three states with the highest carbon intensity dominating EU supply, account for 64 per cent (5,179 tonnes) of the total imports into the country, with Mato Grosso alone accounting for one-third.

The UK is a striking example of how trade volume alone does not determine the embedded carbon footprint of

imported beef. While the country is Europe's second largest recipient country by weight (28,030 tonnes), it has the lowest carbon footprints among the top five recipient countries. This is explained by the fact that 89 per cent of imports into the UK come from the southern states of São Paulo and Rio Grande do Sul (though an important proviso is that most of these imports are of corned beef, which is more likely than fresh or frozen beef to have originated from the Amazon states even if it was exported from the south – see company analysis below for further discussion).

São Paulo and Rio Grande do Sul have significantly lower levels of deforestation – and, as a consequence, lower carbon emissions from forest loss – compared to Mato Grosso, Goiás and Mato Grosso do Sul. As a result, countries importing a larger share of their beef from these two states are exposed to lower carbon footprints in their overall purchases.

The combined upper-average carbon footprint (when deforestation is included) of Europe's top five recipient countries of Brazilian beef amounts to nearly 2.6 million $tCO_2e$. This is equivalent to the 2018 carbon emissions of 298,148 Europeans.[28] Exports from Mato Grosso alone account for almost 2.2 million $tCO_2e$, or 85 per cent of this total carbon footprint.

## Degraded pastures in Mato Grosso

The carbon footprint estimates discussed above – established using state-level averages – fail to capture potentially higher carbon emissions embedded in European imports of Brazilian beef. In Mato Grosso, for example, each kilo of beef produced from cattle reared in degraded pastures associated with deforestation generates 1,695kg $CO_2e$.

A sufficient weight of beef is understood to have been produced from degraded pastures in Mato Grosso to supply over one-third (35.5 per cent) of all imports from the state into the top five European recipient countries – assuming all such beef were shipped to these countries (see annex 1).

If that were the case, and the remainder of imports from Mato Grosso and the other four states were still estimated using the state-level upper-average, the total carbon footprint embedded in European imports of Brazilian beef could be as high as 20.8 million $tCO_2e$.[29] This would be equivalent to the annual carbon emissions of 2.4 million

28 Based on average European per capita emissions for 2018 of 8.6 $tCO_2e$ according to the European Environment Agency (EEA), available at https://ec.europa.eu/eurostat/databrowser/view/t2020_rd300/default/table?lang=en.

29 Calculated by multiplying 35.5 per cent of European imports from Mato Grosso by the carbon footprint for degraded pastures with deforestation, and the remaining 64.5 per cent using the state level upper-average emissions estimate for Mato Grosso.

## Estimated carbon footprints embedded in European beef imports from Mato Grosso

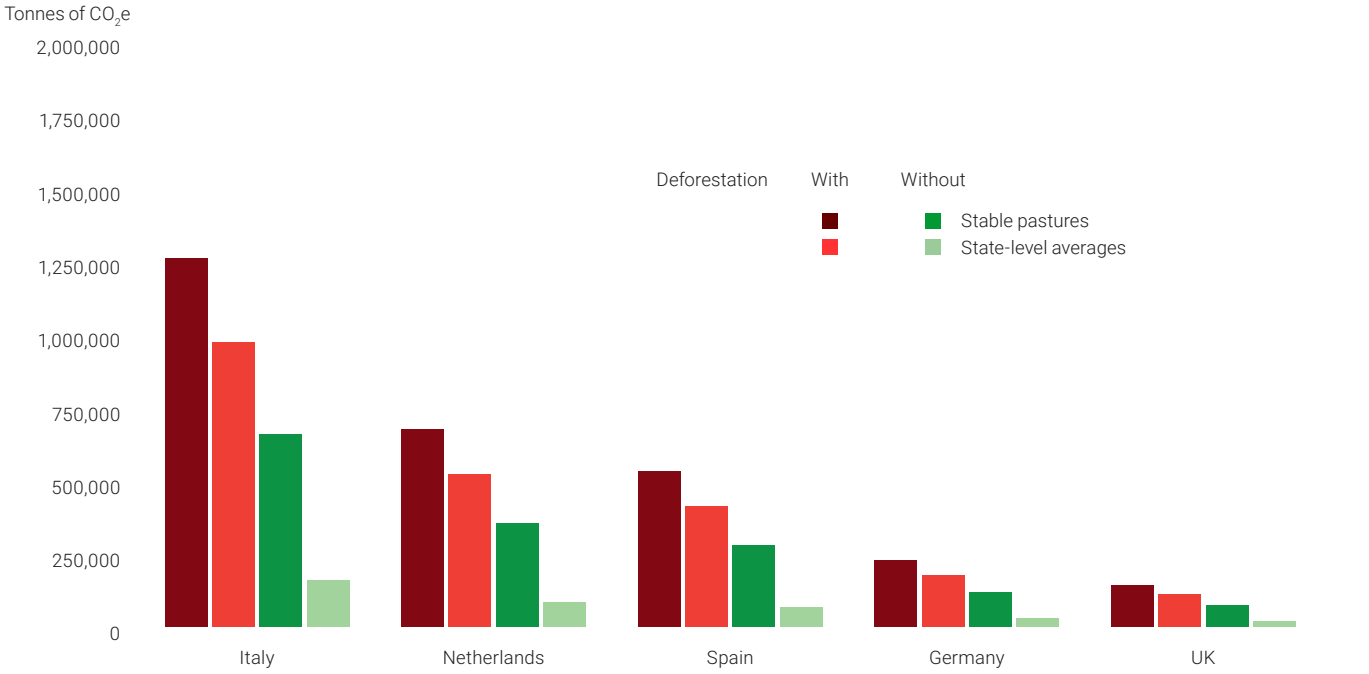


**Figure 3:** *Estimated carbon footprints embedded in imports of beef from Mato Grosso alone. The chart shows the state-level carbon footprints (light colours) and the estimated carbon footprints if all beef imports were linked to cattle farmed in stable pastures only (dark colours). See annex 1 for the detailed data.*

Europeans – over eight times that suggested when only the state-level upper-averages are applied.

### *Stable pastures*

While beef production linked to degraded pastures is proportionately small across all states, production from stable pastures – the second most carbon intensive type of herd management – is easily large enough in all five states to supply all the beef imported into Italy, the UK, the Netherlands, Spain and Germany from those states – with plenty left over for other markets such as those in Asia.

If all the beef imported into these countries came only from cattle reared in stable pastures in all five Brazilian states, the total carbon footprint embedded in these imports would be as high as 4.9 million $tCO_2e$ (see annex 1). This is nearly double the carbon footprint associated with state-level upper-averages outlined above, and would be equivalent to the average annual carbon emissions of 565,800 Europeans.

Italy's imported carbon footprint – when considering the state-level upper-averages – equates to the annual per capita emissions of 151,060 of its citizens – equivalent to the population of Livorno, the port city where many of its Brazilian beef imports arrive.[30] But if all Brazilian beef imports into the country came from cattle reared in stable pastures on deforested land, the embedded carbon footprint would reach 1.8 million $tCO_2e$, equivalent to the annual per capita emissions of 249,807 Italians.

The other four European countries would also have significantly higher embedded carbon footprints if all their beef came from stable pasture. For the Netherlands and Germany, the numbers would nearly double (from 633,124 to almost 1.2 million $tCO_2e$ and from 224,623 to 426,424 $tCO_2e$ respectively, see annex 1). For the UK it would increase fivefold (from 152,294 to 767,975 $tCO_2e$).

This would take the UK past Germany and Spain – which have embedded carbon footprints of 426,424 and 673,560 $tCO_2e$ respectively when considering only stable pastures with deforestation – in the emissions rank, explained by the UK's much larger imported carbon footprints from stable pastures in São Paulo and Rio Grande do Sul (see annex 1).

It is notable that while São Paulo is Brazil's largest beef exporter to Europe overall, the top five European importing countries received more beef from slaughterhouses in Mato Grosso (32,129 tonnes) than in São Paulo (28,122 tonnes). This has important implications for these countries' – and thus Europe's – overall carbon footprints embedded in Brazilian beef consumption, as they are more exposed to Mato Grosso's higher emission levels than to any other state in Brazil.

### *Getulio Vargas Foundation Estimates*

The Getulio Vargas Foundation study published in October 2019 provided estimates of carbon footprints of Brazilian beef exported to the EU ranging from 27kg $CO_2e$/kg beef to 99kg $CO_2e$/kg beef.[31]

Applying this range to 2019 imports from the top five Brazilian states of export into the aforementioned five European countries suggests that the carbon emissions embedded in this trade vary between 2.6 million $tCO_2e$ and 9.6 million $tCO_2e$. These would be equivalent to the annual emissions of 305,447 and 1.1 million Europeans (compared to 565,800 Europeans when calculated against stable pastures with deforestation).

These carbon emissions are higher than the ranges of both the state-level averages (614,450 and 2.6 million $tCO_2e$) and stable pastures (3.4 and 4.9 million $tCO_2e$) presented above.

The GVF estimates suggest the emissions embedded in imports into each of the five European countries of destination are: Italy (800,544 to 2.9 million $tCO_2e$), the UK (756,822 to 2.8 million $tCO_2e$), the Netherlands (596,273 to 2.2 million $tCO_2e$), Spain (255,570 to 937,088 $tCO_2e$), and Germany (217,633 to 797,988 $tCO_2e$).

Unlike the ranking based on state-level upper-average estimates, the ranking derived from the GVF study mimics the trade volume rank as it does not take state of origin into account. Crucially, the upper estimates for each country are also significantly higher than even the estimates calculated by this study using stable pastures with deforestation as a basis (see annex 1).

These results suggest that the carbon footprints embedded in European imports of Brazilian beef based on Instituto Escolhas' values are conservative. This is likely due to the fact that exporting slaughterhouses may be sourcing part of their cattle from neighbouring states with higher carbon footprints (see methodology for a more detailed discussion on this point).

30 Average Italian per capita emissions for 2018 of 7.3 $tCO_2e$. See https://ec.europa.eu/eurostat/databrowser/view/t2020_rd300/default/table?lang=en.

31 Centro de Estudos em Sustentabilidade (FGVces) da Fundação Getulio Vargas (FGV EAESP), "Pegada de carbono da carne bovina brasileira exportada para a União Europeia", October 2019, available at http://mediadrawer.gvces.com.br/publicacoes-2/original/pccbb_sumario-executivo_27nov.pdf.

# Company analysis

## *State-level emissions averages*

**As observed for European countries of import, the potential embedded carbon footprints of the importing companies are influenced more by the Brazilian state of production than the volume of their imports.**

The top 10 companies importing beef from the top five Brazilian states are JBS (15,728 tonnes), Marfrig (10,145 tonnes), Silca (9,397 tonnes), Princes (6,175 tonnes), Bervini Primo (4,256 tonnes), Tonnies Fleisch (3,512 tonnes), Bolton Group (3,357 tonnes), Fn Global Meat (2,749 tonnes), Intervlees (2,589 tonnes), and Frostmeat Fleischandelsgesellschaft (2,580 tonnes).

However, when estimating these firms' average carbon footprints – again using state-level averages – their ranking changes significantly. Silca has the highest footprints – without and with deforestation – from 89,708 to 375,000 $tCO_2e$. It is followed by JBS (41,166 to 221,538 $tCO_2e$), Tonnies Fleisch (36,199 to 199,411 $tCO_2e$), Bervini Primo (49,075 to 181,660 $tCO_2e$), Frostmeat (26,717 to 106,053 $tCO_2e$), Intervlees (26,210 to 100,654 $tCO_2e$), Eastfield Meat (20,551 to 82,276 $tCO_2e$), Fn Global Meat (20,692 to 80,253 $tCO_2e$), Merlo Ercole (19,227 to 74,328 $tCO_2e$), and Egatesa (15,247 to 64,513 $tCO_2e$). (See figure 4).

While Italian firm Silca is Europe's third largest importer, it tops the chart of average carbon footprints. The company buys half of its beef from slaughterhouses in Mato Grosso and four-fifths from Mato Grosso, Goiás and Mato Grosso do Sul. Silca produces various products for the meat market in Italy, including bresaola and processed meats[32] along with selling a frozen range in stores and online.[33]

The upper-average carbon emissions embedded in Silca's beef imports alone would be the equivalent to the annual average carbon emissions of 51,370 Italians.

JBS, while importing over 65 per cent more beef than Silca, has an upper-average carbon footprint 41 per cent smaller because two-thirds of its beef are shipped from slaughterhouses in São Paulo – and therefore assumed not to be linked to deforestation – and only 19 per cent from Mato Grosso. Beef the JBS group imports from the

32 Silca, https://web.archive.org/web/20171108055905/http:/www.silcaspa.it/it/servizi/commercio.

33 See, for example, https://prontospesa.gelmarket.it/spesa-ritiro-negozio/via-cadore-27/ricerca?search=trippa and https://www.alisur-martis.it/prodotti.php?cat_id=5.

## *Estimated carbon footprints embedded in European imports of Brazilian beef*

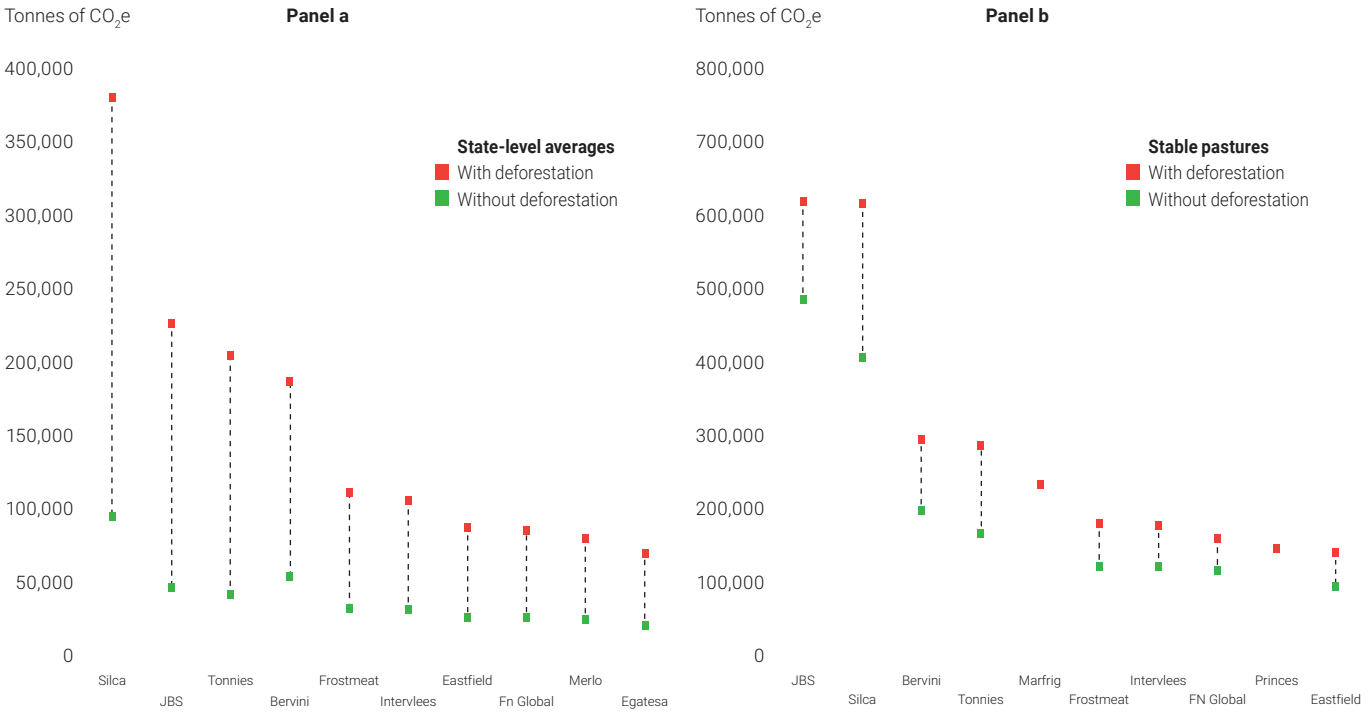


**Figure 4:** *Estimated carbon footprints embedded in beef imports of 10 European importers – into the top five countries of import – from the top five Brazilian states of export. Panel a shows the state-level carbon footprints while panel b shows the footprints if all imports were linked to cattle farmed in stable pastures only. Company ranks change in each panel, with neither reflecting rank by trade volume. See annex 2 for the detailed data. Note that Marfrig and Princes only have one value each for stable pastures with or without deforestation (panel b), explained by the fact that forest loss linked to stable pastures in São Paulo and Rio Grande do Sul, the states where their beef come from, is not a relevant factor in the carbon footprint of beef production. See analysis for more details.*

five Brazilian states to Europe is destined for the British and Dutch markets (under its JBS Global UK/JBS Group/ JBS entities) with 72 per cent going to the UK (the firm is a known supplier to several UK supermarkets).[34]

JBS's embedded carbon emissions would be the same as those of 25,760 EU citizens.

The German food giant Tonnies is a comparatively more modest importer than JBS or Silca by weight, but has estimated average carbon footprints rivalling the former, due to 80 per cent of its beef coming from meatpackers in Mato Grosso. The company's embedded carbon footprint – estimated using the state-level upper-averages highlighted above – equates to the annual average emissions of 23,187 Europeans. Despite being German-owned, 88 per cent of its imports from the five exporting states – under Tonnies Fleisch and Tonnies Fleisch Italia names – are to supply the Italian market.

While Frostmeat is the tenth largest importer by weight, it comes fifth in the estimated carbon footprint ranking. Slaughterhouses in Mato Grosso, Goiás and Mato Grosso do Sul supply 86 per cent of the Brazilian beef the German firm imports to Europe, with just over half imported from Mato Grosso alone.

Three companies not among the top 10 largest importers by weight are nonetheless represented among the top 10 firms with the highest upper-average carbon footprints – when deforestation is accounted for. Eastfield Meat (UK), Merlo Ercole (Italy) and Egatesa – a supplier to Spain's supermarkets – rely on Mato Grosso, and to a lesser extent on Mato Grosso do Sul and Goiás, for large shares of their imports (see annex 2).[35]

Commensurately, some of the largest importers by weight are pushed out of the top 10 average carbon footprints ranking. One of the most striking examples is Marfrig, the second largest importer by weight and among the top three meatpackers in Brazil overall. The firm, which supplies the Dutch, British and German markets, buys 93 per cent of its beef from facilities in Rio Grande do Sul, with the remaining coming from São Paulo. Marfrig has the 21st largest upper-average carbon footprint as a result.

A similar pattern can be observed for Princes (UK), the fourth largest importer by weight, but whose upper-average carbon footprint comes 28th in the embedded emissions ranking in the analysis. This is because all of Princes' imports come from suppliers in the southern state of Rio Grande do Sul.

Bolton Group is possibly the biggest outlier when translating beef trade volumes into average carbon footprint estimates. The Italian firm, which imports 99 per cent of its beef from São Paulo, is the seventh largest importer but ranks last in average carbon footprint estimates among the more than 150 companies importing beef products from the five Brazilian states into Europe.

## "Facilities in southern states likely source beef from slaughterhouses further north, in the Amazon and Cerrado"

However, it is important to note that beef shipped from southern Brazilian states is not necessarily free from deforestation, as part of the cattle slaughtered by meatpackers in the region may come from states in the Cerrado or Amazon biome. Furthermore, Princes and Bolton are large buyers of corned beef and other types of canned meat. Exporting facilities in southern states likely source part of the fresh beef they transform into these highly processed products from slaughterhouses further north that are more closely linked to ranches in the Amazon or Cerrado. Therefore, Princes' and Bolton's carbon footprints are in reality likely to be much higher than the estimates given here, which do not take these factors into account.[36]

Similar cases to these, where the location of production in Brazil creates such changes in rankings, can be seen in annex 2.

The Spanish importers Montesano Canarias and Jucarne do not figure among the 20 largest importers but do appear among the 20 firms with the highest upper-average carbon footprints. Jucarne, a supplier to Spanish supermarket chain Alcampo, relies on slaughterhouses in Mato Grosso for 88 per cent of its supplies.[37] Montesano, which also supplies Alcampo[38] and overseas markets, buys all its beef from meatpackers in Mato Grosso, Mato Grosso do Sul and Goiás.[39]

34 Earthsight, "Bad beef: UK retailers feed illegal deforestation fears as corned beef imports from corruption-hit Brazilian firm persist", 5 May 2019, available at https://www.earthsight.org.uk/news/idm/brazil-corned-beef-jbs-uk-supermarkets-deforestation-amazon.

35 Mercadona, "Annual report 2018", available at https://info.mercadona.es/document/en/annual-report-2018.pdf.

36 See the methodology section for a more detailed discussion on the use of slaughterhouses' addresses for this study and how this may lead to conservative estimates of the carbon footprint embedded in European beef imports.

37 See, for example, https://www.alcampo.es/compra-online/frescos/carne/burguer-meat-y-picada/jucarne-burger-meat-2-x-80-g/p/69376.

38 See, for example, https://www.alcampo.es/compra-online/frescos/carne/burguer-meat-y-picada/montecarne-preparado-carne-picada-vacuno/p/521405.

39 Carmelo Rivero, "'Vendemos millones de jamones Montesano en el mundo con oficinas en Japón y China'", Diario de Avisos, 27 December 2015, available at http://www.diariodeavisos.com/2015/12/vendemos-millones-jamones-montesano-en-mundo-con-oficinas-en-japon-china/.


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## *Degraded pastures in Mato Grosso*

As with the country-level analysis, carbon footprint estimates for importers significantly rise when higher emitting herd management types are considered, rather than just the state-level averages. Beef production linked to degraded pastures on deforested lands in Mato Grosso is large enough to hypothetically supply all the beef purchased by the three largest European importers from that state (Silca, JBS, and Tonnies Fleisch).

If all of Silca's imports from Mato Grosso were linked to degraded pastures associated with deforestation – while still considering the state-level upper-average emissions for the other four states of origin – the embedded carbon footprint of its imports of Brazilian beef would be 8 million $tCO_2e$ – 21 times greater than is the case when only the state-level upper-average is applied. Similarly, if JBS's Mato Grosso imports were also all derived from degraded pasture linked to deforestation, its imports into Europe would embody emissions 22 times larger (5 million $tCO_2e$) than under a state-level upper-average across all states.

This scenario would equate Silca's embedded carbon footprint to the average per capita emissions of 1.1 million Italians – more than the population of Naples, the country's second largest city. JBS's imports would have the same carbon footprint as the per capita average of 578,991 Europeans.

## *Stable pastures*

As we have seen, in all five Brazilian states the slaughter of cattle reared in stable pastures produces easily enough beef to supply all demand from Italy, the UK, the Netherlands, Spain and Germany. When calculated based on all imported beef originating from cattle reared on stable pastures linked to deforestation rather than using state-level upper-averages, the estimated carbon footprints of the individual companies doing the importing rise considerably, as annex 2 shows (see also figure 4).

By this measure, JBS's embedded carbon emissions nearly treble, taking the firm above Silca as the importer with the highest embedded footprint. Bervini Primo overtakes Tonnies Fleisch for third place and Fn Global Meat climbs one position to occupy seventh place.

Egatesa drops out of the top ten list and is replaced by Casasco & Nardi, which sees its estimated footprint almost double. Similar changes in rankings can be observed across the top 20 importers (see annex 2).

It is striking to note that, when measuring carbon footprints based only on stable pastures with deforestation, Marfrig, Princes and Bolton Group climb up the rank, sometimes in dramatic fashion. Marfrig goes from 21st to fifth place, with an estimated carbon footprint of 223,189 $tCO_2e$ – a more than eight-fold increase from its state-level upper-average estimate.

Princes moves up 19 places to ninth (135,845 $tCO_2e$, a seven-fold increase). Bolton Group leaves the last position among importers to occupy position 15 on the rank (with 73,275 $tCO_2e$ of estimated emissions).

These dramatic moves are explained by the differences observed in carbon intensities when comparing state-level upper-averages with stable pasture emissions – factoring deforestation in – within each state.

While carbon emissions from stable pastures with deforestation in Mato Grosso (88kg $CO_2e$/kg beef), Goiás

(56kg $CO_2$e/kg beef) and Mato Grosso do Sul (48kg $CO_2$e/kg beef) are, respectively, only 1.3, 3.5 and 1.9 times greater than their upper-average emissions (68, 16 and 25kg $CO_2$e/kg beef respectively), the differences in São Paulo and Rio Grande do Sul are significantly more pronounced.

Average emissions in São Paulo are -2kg $CO_2$e/kg beef, but its emissions from stable pastures with deforestation are 22kg $CO_2$e/kg beef. In Rio Grande do Sul emissions increase more than seven-fold, from 3 to 22kg $CO_2$e/kg beef.[40]

While companies importing exclusively or predominantly from lower-level emissions states São Paulo and Rio Grande do Sul (such as Marfrig, Princess and Bolton Group) can appear to be exposed to low or lower embedded emissions, if stable pastures linked to deforestation play a major role in their supply chains their emissions can dramatically rise.

The combined footprint of the 20 importers with the highest estimated embedded carbon emissions by state-level upper-averages increases by 72 per cent if calculated by stable pastures with deforestation instead (from 1.9 to 3.2 million $tCO_2$e).

In this scenario, the 3.2 million $tCO_2$e in estimated embedded emissions would be equivalent to the average 2018 per capita carbon emissions of 375,740 Europeans.

## *Marfrig's estimated emissions*

Marfrig was the only company to reply to questions about their beef sourcing policies and their carbon footprints. The firm provided an estimated carbon footprint for its beef ranging from 48 to 99kg $CO_2$e/kg beef.

Applying these estimates against Marfrig's 2019 imports (10,145 tonnes) reveals a range of embedded carbon footprints between 486,958 and 1 million $tCO_2$e. These are significantly higher than the upper-average estimates calculated for the company using Instituto Escolhas' values for both state-level average (26,723 $tCO_2$e) and stable pastures (223,189 $tCO_2$e).

If the upper estimate is considered, Marfrig's imports alone would be equivalent to the annual carbon emissions of 116,785 Europeans.

These new estimates would place Marfrig above Silca and JBS as the European importer with the highest embedded carbon footprints.

However, as the GVF study from which Marfrig derives its embedded emissions was also facilitated by JBS, Minerva, and a range of Brazilian government and beef sector trade bodies, and are considered a sectoral estimate rather than company specific, to apply them only to Marfrig and not to other companies in this sample would appear inconsistent.

Yet, as JBS has not provided any estimate for this analysis, the emissions embedded in its European imports have not been calculated using the GVF figures. Nonetheless, the country analysis above does apply these GVF figures to the overall imports into Italy, the UK, the Netherlands, Spain and Germany – generating significant increases across the board (see above and annex 1).

Applying the wider range of 27 to 99kg $CO_2$e/kg beef also provided by the GVF study, Marfrig's estimated embedded carbon footprint would have a lower range of 273,914 $tCO_2$e, still higher than the estimate based on the carbon intensity of stable pastures as defined by Instituto Escolhas.

When submitting data for this analysis, Marfrig stated that the company "seeks to strengthen the relationship between producers and Marfrig by encouraging the adoption of good livestock practices, which contributes to the sustainable development of the farms and ensures safer production with less environmental impact." The firm also says that it monitors the carbon footprint of its beef production based on internationally-recognised methods and that it "believes that it is possible to have a low carbon sustainable livestock that keeps environmental preservation, maintenance of existing biomes and sustainability without [the need] to suppress native vegetation or open new areas for production."

## *Concentration of embedded emissions*

Importantly, relatively few importers account for a majority of all emissions embedded in imports of Brazilian beef into Italy, the UK, the Netherlands, Spain and Germany, which supports previous analysis conducted by the supply chain transparency platform Trase.[41] When taking state-level upper-average emissions, Silca and JBS alone account for nearly one-quarter (596,539 $tCO_2$e) of the 2.6 million $tCO_2$e total.

40 The average carbon footprints in São Paulo (-2kg $CO_2$e/kg beef) and Rio Grande do Sul (3kg $CO_2$e/kg beef) do not change when deforestation is factored in, which means that their upper and lower averages are the same. Similarly, the carbon footprints of beef produced on stable pastures in these states are also unaltered when deforestation is accounted for. This is mostly because forest loss has not been a relevant factor for stable pastures in these states over the past decade.

41 See Trase's supply chain data on a variety of commodities, including beef, at https://trase.earth/.

The eight companies importing the highest estimated embedded emissions are responsible for over half (1.3 million $tCO_2e$) of the total of more than 150 European firms buying beef from the aforementioned five states in Brazil.[42]

Eighty per cent of all carbon emissions associated with imports of Brazilian beef into the five European countries from the five main states of export are embedded in trade conducted by just 27 companies.[43]

This dramatic concentration of embedded emissions in a comparatively small number of individual companies' trade flows plays out across all different scenarios – whether applying state-level averages, stable pasture-only averages, or Mato Grosso's degraded pasture averages – although the rankings of specific companies alter.

Some European firms have higher embedded carbon footprints – when calculated based on state-level upper-average emissions – than some recipient countries. Italian firm Silca has a higher estimated footprint (375,000 $tCO_2e$) than Germany (224,623 $tCO_2e$) or the UK (152,294 $tCO_2e$). JBS (221,538 $tCO_2e$), German importer Tonnies Fleisch (199,411 $tCO_2e$), and Italian company Bervini Primo (181,660 $tCO_2e$) also have higher embedded emissions than the UK (see figure 5). It is important to note that while Tonnies Fleisch is a German firm, most of its imports are destined for the Italian market.

These findings will be of interest to policy makers seeking to reduce imported embedded emissions in general, but also specifically for imports of agricultural products where production is also a driver of deforestation.

Should European policy makers introduce targeted regulation to eliminate or reduce the forest – and consequently the carbon – footprints of imported agricultural products, measures to ensure importers know the actual origin of their meat, and eliminate purchases of beef derived from deforestation, will be critical.

42 Ranked by state-level upper-average carbon footprints: Silca, JBS, Tonnies Fleisch, Bervini Primo, Frostmeat, Intervlees, Eastfield Meat, and Fn Global Meat.

43 They are: Silca, JBS, Tonnies Fleisch, Bervini Primo, Frostmeat, Intervlees, Eastfield Meat, Fn Global Meat, Merlo Ercole, Egatesa, Casasco & Nardi, Agro Co. Di Giuseppe Comparoni And C, Montesano Canarias, Quabas Group, Meat Imp. Zandbergen Brothers, Fritz Vieh Und Fleischhandel, Jucarne, E. Jacobsen, Gvfi Europe/International, Jan Zandbergen, Marfrig, Importo, Towers &Co., Tulling Meat Imp., Inalca Sp A Group, Toledo Impormit, Menceyes Food.

## *Estimated carbon footprints embedded in European imports of Brazilian beef*

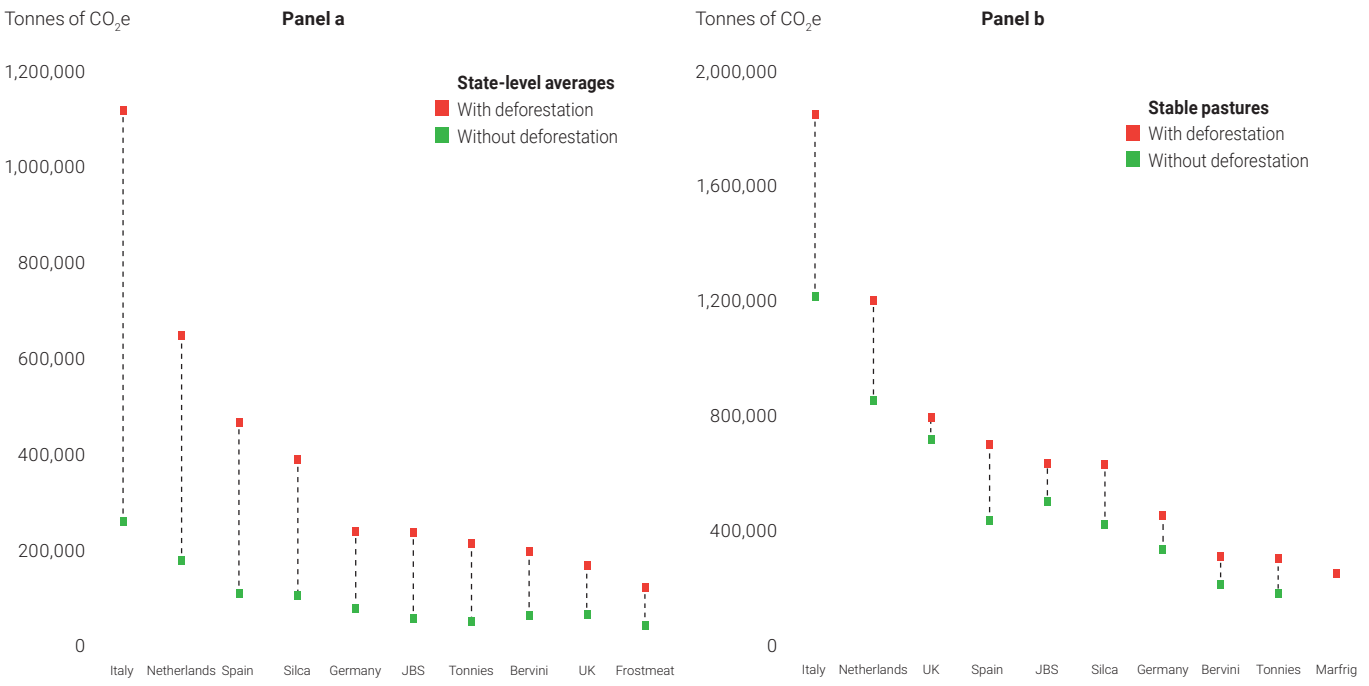


**Figure 5:** *Estimated carbon footprints embedded in beef imports into Italy, the UK, the Netherlands, Spain and Germany, and the five importing companies with the highest footprints measures by state-level averages and stable pasture estimates. Note that in both scenarios some companies have higher estimated carbon footprints than certain countries. Note that Marfrig only has one value for stable pastures with or without deforestation (panel b), explained by the fact that forest loss linked to stable pastures in São Paulo and Rio Grande do Sul, the states where its beef come from, is not a relevant factor in the carbon footprint of beef production. See analysis for more details.*

# Review of past studies

**A number of exercises similar to this study have been conducted. Trase, a supply chain transparency platform run by Global Canopy and the Stockholm Environment Institute, provides deforestation-related carbon emissions estimates for Brazilian beef exports to Europe, including breakdowns by source municipalities, exporting and importing firms, and countries of destination.[44] Such data are available for 2015, 2016 and 2017.[45]**

According to Trase data, EU imports of Brazilian beef embedded 1.05 million $tCO_2$ in 2017. Italy (386,243 $tCO_2$), the Netherlands (262,963 $tCO_2$), Spain (137,672 $tCO_2$), the UK (89,538 $tCO_2$), and Germany (84,793 $tCO_2$) were the countries with the highest embedded carbon footprints.

This study identifies the same five countries as Europe's top importers, both in trade volumes and embedded carbon emissions. But it provides markedly different, and often higher, $CO_2$ values for each importing country (see the country analysis section).

Crucially, Trase only provides one carbon footprint estimate per importing country and company, while this study provides a range of figures based on state-level averages and for stable pasture averages, both with and without the deforestation factor (see methodology and analysis sections).

Earthsight's analysis estimates that Italy, for example, has an estimated carbon footprint of 1.1 million $tCO_2e$ embedded in its beef imports from Brazil's top five exporting states when deforestation is factored in and state-level average carbon emissions are applied. But if deforestation is excluded from the calculation, Italy's embedded footprint drops to 253,347 $tCO_2e$, which is much closer to and lower than Trase's figure.

It can thus be problematic to make simple comparisons between Trase's single carbon emissions figures and the more nuanced ranges presented here.

When looking at embedded emissions by importing company, Trase and this analysis again provide similar names but in significantly different orders and with different values (see the company analysis section).

Unlike this study, which is based on the carbon footprint of the entire beef production cycle, Trase's data only include deforestation-related carbon emissions. It is also important to note that this analysis and Trase use different trade data sources and methods.

A study published in 2015 by Sabine Henders, Martin Persson and Thomas Kastner provided figures for land-use change and carbon emissions embedded in the global exports of four commodities from seven producing countries, among them Brazilian beef.[46] The paper, which covered the 2000-2011 period and did not include breakdowns by European destination country or importer, calculated that in 2011 Brazilian beef imports into the EU embedded 30.1 million $tCO_2$ and 63,900ha of land-use change.[47]

This is considerably higher than the embedded emissions ranges calculated by Earthsight's analysis for Brazilian beef exported to the main European importing countries (see country analysis). Like Trase, Henders and her colleague's study based carbon emissions solely on land-use change. They analysed flows of agricultural products through international supply chains while eliminating transit countries where only processing takes place, thus ensuring that exports were correctly assigned to countries where the commodities were consumed.

## "Forest loss is the main contributor to the carbon footprint of Brazilian beef"

Importantly, the study found that in 2011 beef was the main driver of forest loss across their case countries, accounting for nearly 60 per cent of embedded deforestation – or 2.1 million hectares, of which 1.6 million took place in Brazil alone – and just over half of embedded emissions.

This cursory review of past analyses suggests that there are significant differences between the studies due to the application of different methodologies and data sets, and the periods covered. The present document analyses more recent trade data and is based on greenhouse gas emissions going beyond deforestation to include the entire production cycle of beef for different Brazilian states, biomes, and types of pasture and herd

44 https://trase.earth/

45 See https://trase.earth/flows?selectedColumnsIds=0_22-1_28-2_37-3_21&selectedResizeBy=203&selectedContextId=6&toolLayout=1&countries=27&destinations=453&commodities=46 for trade flows and https://trase.earth/flows/data-view?selectedColumnsIds=0_22-1_28-2_37-3_21&selectedResizeBy=203&selectedContextId=6&toolLayout=1&countries=27&destinations=453&commodities=46 for data. Trase carbon footprint estimates are also available for a variety of commodities exported by a number of producing countries to several markets.

46 Henders, S. et al, "Trading forests: land-use change and carbon emissions embodied in production and exports of forest-risk commodities", Environmental Research Letters, 22 December 2015, Vol. 10, Number 12, IOP Publishing. Available at https://iopscience.iop.org/article/10.1088/1748-9326/10/12/125012#erlaa0aacs3.

47 Full data available on the supplementary data files at https://iopscience.iop.org/article/10.1088/1748-9326/10/12/125012#erlaa0aacs3.

management systems – while acknowledging that forest loss is the main contributor to the carbon footprint of Brazilian beef.

It is interesting to note that this analysis suggests higher embedded carbon footprints than Trase's data but lower than the ones estimated by Henders and her colleagues. This illustrates the complexities of putting a firm figure on greenhouse gas emissions embedded in exports of Brazilian beef to Europe. It also underscores the need for more transparency from the industry and wider availability of public data on the cattle industry in Brazil.

# Conclusion

**The various scenarios of carbon emissions embedded in European imports of Brazilian beef outlined above always include a significant range – with upper-averages assuming deforestation plays a role in pasture development and lower-averages assuming it does not.**

Assuming the carbon intensity values (from Instituto Escolhas, and Getulio Vargas Foundation) applied to actual trade data are valid (although they differ methodologically), it is reasonable to conclude that the actual carbon footprint embedded in European imports for a given country or company lies somewhere within the ranges discussed above.

A systematic absence of detailed monitoring or reporting of deforestation or herd management/pasture types connected to thousands of actual ranches providing cattle to slaughterhouses suppling Europe makes for a complete lottery as to where, within the emissions ranges cited above, or indeed within which scenario, the embedded carbon emissions of Europe's Brazilian beef imports really lie.

The only company to have provided information for this study – Marfrig – cited carbon footprint estimates produced by the Getulio Vargas Foundation (GVF) which were markedly higher than those suggested by Instituto Escolhas' averages – whether for Brazil as a whole, state-level averages, or averages for stable pastures alone.

These considerably higher carbon footprint figures were produced in collaboration with the top three meatpackers in Brazil, and government and industry bodies, and significantly worsen the estimated emissions compared to those based solely on Instituto Escolhas' study. While the GVF estimates are based on a sample of actual farms – meaning they may be more evidentially valid than the more statistical model used by Instituto Escolhas – they are still focused on only 23 ranches. The study is described as one of the first of its kind, indicating the systemic absence of information on the deforestation and carbon footprint of Europe's imports from Brazil.

And herein lies a challenge – not with the study, but with the sector.

No single slaughterhouse supplying Europe, nor any major European importer of Brazilian beef is understood to have an actual, reliable measure of either the emissions or the degree of actual deforestation embedded in the traded beef.

Wherever emissions do lie, both the higher and lower embedded emissions estimates across all scenarios present problematic climate outcomes should they persist – with the upper-estimates also presenting worrying deforestation and biodiversity-loss outcomes.

That a significant portion of deforestation linked to cattle ranching in Brazil is deemed to be illegal – and particularly in Mato Grosso, a critical state in the European supply – only makes the case more pressing.[48]

European governments have explicitly recognised these realities, and pledged to act[49] – with some states even suggesting boycotts of Brazilian beef – but none have yet instituted reliable measures to do so.[50]

To date there are no requirements on any companies placing Brazilian beef (or any agricultural product from

48 Mapbiomas, "Relatório anual do desmatamento do Brasil – 2019", May 2020, available at http://alerta.mapbiomas.org/relatorios.

49 Arthur Neslen, "EU states call for tough action on deforestation to meet 2020 UN goal", The Guardian, 12 November 2018, available at https://www.theguardian.com/environment/2018/nov/12/eu-states-call-for-tough-action-on-deforestation-to-meet-2020-un-goal-amsterdam-declaration.

50 Anne Kauranen, "Finland urges EU to consider banning Brazilian beef over Amazon fires", Reuters, 23 August 2019, available at https://www.reuters.com/article/us-brazil-politics-eu-beef/finland-urges-eu-to-consider-banning-brazilian-beef-over-amazon-fires-idUSKCN1VD17R.

any country) on European markets to conduct due diligence into the deforestation impacts of those products, let alone to stop sourcing them where the impacts and risks involved are understood and deemed unacceptable.

The current lack of information on the origin and environmental impacts of such products should not be a reason not to demand it. It is perfectly feasible, given sufficient political, regulatory and market incentives, for any sector to develop monitoring and traceability systems capable of ensuring European markets do not reward deforestation and, consequently, high carbon footprints.

In the case of Brazilian beef, all that is needed is that existing, but stand-alone systems be joined up.

Slaughterhouses shipping to Europe must already know the ranches supplying them through the Sisbov and Trace List systems, but these are not environmental monitoring tools. Animal Transit Permits (GTAs) could inform slaughterhouses of who their indirect suppliers are but are not currently legally available to them. Remote sensing tools and a booming industry of consultancies using them could assist slaughterhouses in identifying destructive or illegal land use across every ranch in their supply chains.

Such screening could effectively employ the already publicly available digital databases of environmental fines and embargoes, slave labour, and the geographical boundaries of registered and licenced farms and reserve areas, indigenous reservations, national and local conservation units, extractive reserves, and other protected areas. But without knowing which farms are involved, all stakeholders face the data constraints that slaughterhouses do.

No market signal – either within or outside of Brazil – currently exists to incentivise the joining up of these existing systems and capacities in Brazil. Until it does, it seems the carbon and deforestation lottery embedded in Europe's imports of Brazilian beef will persist both unquantified and unabated.

# Annexes

## Annex 1: European countries of destination

**Table 2:** *Estimated carbon footprints of European imports of Brazilian beef in 2019 (tCO2e)*
*Top five Brazilian states of origin and top five European countries of destination*

| | Herd management system with and without deforestation | Mato Grosso | São Paulo | Rio Grande do Sul | Goiás | Mato Grosso do Sul | Totals | GVF estimates* |
|---|---|---|---|---|---|---|---|---|
| Italy | State average with deforestation | 970,955 | -15,366 | 727 | 70,621 | 75,799 | **1,102,735** | **800,544 to 2,935,328** |
| | State average without deforestation | 157,066 | -15,366 | 727 | 35,310 | 66,703 | **244,440** | |
| | Stable pastures with deforestation | 1,256,530 | 169,028 | 5,328 | 247,173 | 145,534 | **1,823,593** | |
| | Stable pastures without deforestation | 656,823 | 169,028 | 5,328 | 216,277 | 142,502 | **1,189,957** | |
| Netherlands | State average with deforestation | 519,618 | -12,733 | 6,132 | 54,586 | 65,522 | **633,124** | **596,273 to 2,186,336** |
| | State average without deforestation | 84,056 | -12,733 | 6,132 | 27,293 | 57,659 | **162,407** | |
| | Stable pastures with deforestation | 672,447 | 140,061 | 44,964 | 191,050 | 125,802 | **1,174,325** | |
| | Stable pastures without deforestation | 351,506 | 140,061 | 44,964 | 167,169 | 123,181 | **826,882** | |
| Spain | State average with deforestation | 410,274 | -2,005 | 777 | 21,353 | 20,901 | **451,298** | **255,570 to 937,088** |
| | State average without deforestation | 66,368 | -2,005 | 777 | 10,676 | 18,393 | **94,208** | |
| | Stable pastures with deforestation | 530,943 | 22,059 | 5,694 | 74,734 | 40,129 | **673,560** | |
| | Stable pastures without deforestation | 277,538 | 22,059 | 5,694 | 65,392 | 39,293 | **409,978** | |
| Germany | State average with deforestation | 173,967 | -3,946 | 2,726 | 24,233 | 27,643 | **224,623** | **217,633 to 797,988** |
| | State average without deforestation | 28,142 | -3,946 | 2,726 | 12,116 | 24,326 | **63,364** | |
| | Stable pastures with deforestation | 225,134 | 43,408 | 19,993 | 84,814 | 53,074 | **426,424** | |
| | Stable pastures without deforestation | 117,684 | 43,408 | 19,993 | 74,212 | 51,968 | **307,266** | |
| UK | State average with deforestation | 109,956 | -22,193 | 41,926 | 19,424 | 3,181 | **152,294** | **756,822 to 2,775,014** |
| | State average without deforestation | 17,787 | -22,193 | 41,926 | 9,712 | 2,800 | **50,031** | |
| | Stable pastures with deforestation | 142,296 | 244,128 | 307,460 | 67,982 | 6,108 | **767,975** | |
| | Stable pastures without deforestation | 74,382 | 244,128 | 307,460 | 59,485 | 5,981 | **691,436** | |
| Totals | State average with deforestation | 2,184,770 | -56,244 | 52,287 | 190,216 | 193,046 | **2,564,074** | **2,626,842 to 9,631,754** |
| | State average without deforestation | 353,419 | -56,244 | 52,287 | 95,108 | 169,880 | **614,450** | |
| | Stable pastures with deforestation | 2,827,349 | 618,685 | 383,441 | 665,754 | 370,647 | **4,865,877** | |
| | Stable pastures without deforestation | 1,477,933 | 618,685 | 383,441 | 582,535 | 362,926 | **3,425,519** | |

**Table 2:** *Estimated embedded carbon footprints in European imports of Brazilian beef for the year 2019. Each country has four estimated footprints: state-level averages (with and without deforestation), and stable pastures (with and without deforestation). See the methodology for a brief explanation about the different herd management systems and how they affect the carbon footprints of beef production. The table is ranked from largest to smallest estimated emissions according to 'state average with deforestation'. Note that the rank in the table below (by trade volume) changes.*
** The column "GVF estimates" provides the estimated ranges of embedded carbon footprints in Brazilian beef exported to the EU according to a recent study published by the Getulio Vargas Foundation. The ranges presented in this column were calculated by multiplying each country's trade volumes by the lowest and highest carbon emissions estimates published by GVF: 27 to 99kg $CO_2$e/kg beef. See the methodology and analysis for more detailed discussions.*

**Table 3:** *Brazilian beef production and European imports*
*Top five Brazilian states of origin and top five European countries of destination*

| | Mato Grosso | São Paulo | Rio Grande do Sul | Goiás | Mato Grosso do Sul | Totals |
|---|---|---|---|---|---|---|
| **Slaughter (2017, heads of cattle)** | **4,804,617** | **2,923,258** | **1,929,178** | **3,179,805** | **3,435,747** | **16,272,605** |
| Degraded pastures | 53,513 | 2,902 | 15,044 | 332 | 0 | 71,791 |
| Stable pastures | 2,067,148 | 200,698 | 222,628 | 1,137,559 | 2,159,160 | 5,787,194 |
| Well managed pastures | 2,021,389 | 2,024,254 | 0 | 1,672,897 | 480,734 | 6,199,274 |
| Integrated systems | 535,002 | 617,533 | 1,544,672 | 284,591 | 704,632 | 3,686,430 |
| Confinement | 127,565 | 77,871 | 146,834 | 84,425 | 91,221 | 527,916 |
| **Estimated beef production (2017, tonnes)*** | **1,025,363** | **623,366** | **336,789** | **654,909** | **694,964** | **3,335,391** |
| Degraded pastures | 11,420 | 619 | 2,626 | 68 | 0 | 14,734 |
| Stable pastures | 441,154 | 42,798 | 38,866 | 234,290 | 436,743 | 1,193,851 |
| Well managed pastures | 431,389 | 431,659 | 0 | 344,548 | 97,240 | 1,304,836 |
| Integrated systems | 114,176 | 131,685 | 269,664 | 58,614 | 142,529 | 716,667 |
| Confinement | 27,224 | 16,606 | 25,634 | 17,388 | 18,452 | 105,303 |
| **European imports (2019, tonnes)** | **32,128.97** | **28,122.05** | **17,429.13** | **11,888.47** | **7,721.82** | **97,290.44** |
| Italy | 14,278.75 | 7,683.07 | 242.20 | 4,413.81 | 3,031.95 | 29,649.78 |
| United Kingdom | 1,617.00 | 11,096.75 | 13,975.47 | 1,213.97 | 127.25 | 28,030.44 |
| Netherlands | 7,641.44 | 6,366.43 | 2,043.84 | 3,411.61 | 2,620.88 | 22,084.20 |
| Spain | 6,033.44 | 1,002.69 | 258.84 | 1,334.54 | 836.03 | 9,465.54 |
| Germany | 2,558.34 | 1,973.11 | 908.78 | 1,514.54 | 1,105.71 | 8,060.48 |

**Table 3:** *Brazilian beef production by herd management type and European imports. See the methodology for a brief explanation about each herd management type. The table allows approximate comparisons between the amount of beef produced and European imports, albeit in different years. The 2017 slaughter and beef production data were kindly provided to Earthsight by Instituto Escolhas. European import data for 2019 were obtained from customs data (through Panjiva).*

** Calculated by subtracting 20% (average bone content of carcass) from the total weight of carcass production. The bone content proportion used here is in accordance with the Instituto de Estudos Pecuários. See https://iepec.com/como-e-calculado-o-rendimento-na-desossa/*

## Annex 2: European importers

**Table 4:** *European importers with the 20 largest state-level upper-average carbon footprints in 2019 ($tCO_2e$)*
*Top five Brazilian states of origin and top five European countries of destination*

| | | State-level average with deforestation | State-level average without deforestation | Stable pastures with deforestation | Stable pastures without deforestation | Imports (tonnes) |
|---|---|---|---|---|---|---|
| **1.** | **Silca A** | **375,000** | **89,708** | **606,171** | **395,609** | **9,397** |
| | Mato Grosso | 320,008 | 51,766 | 414,128 | 216,476 | 4,706 |
| | Goiás | 26,681 | 13,341 | 93,385 | 81,712 | 1,668 |
| | São Paulo | -3,184 | -3,184 | 35,025 | 35,025 | 1,592 |
| | Mato Grosso do Sul | 30,911 | 27,202 | 59,349 | 58,113 | 1,236 |
| | Rio Grande do Sul | 584 | 584 | 4,283 | 4,283 | 195 |
| **2.** | **Jbs** | **221,538** | **41,166** | **608,635** | **475,242** | **15,728** |
| | São Paulo | -21,105 | -21,105 | 232,152 | 232,152 | 10,552 |
| | Mato Grosso | 198,850 | 32,167 | 257,336 | 134,516 | 2,924 |
| | Goiás | 22,194 | 11,097 | 77,678 | 67,968 | 1,387 |
| | Mato Grosso do Sul | 21,599 | 19,007 | 41,470 | 40,606 | 864 |
| **3.** | **Tonnies Fleisch** | **199,411** | **36,199** | **276,564** | **156,205** | **3,512** |
| | Mato Grosso | 191,568 | 30,989 | 247,911 | 129,590 | 2,817 |
| | Goiás | 4,287 | 2,143 | 15,003 | 13,128 | 268 |
| | São Paulo | -528 | -528 | 5,808 | 5,808 | 264 |
| | Mato Grosso do Sul | 4,085 | 3,595 | 7,843 | 7,679 | 163 |
| **4.** | **Bervini Primo Srl** | **181,660** | **49,075** | **284,420** | **187,161** | **4,256** |
| | Mato Grosso | 148,632 | 24,043 | 192,347 | 100,545 | 2,186 |
| | Mato Grosso do Sul | 23,675 | 20,834 | 45,456 | 44,509 | 947 |
| | Goiás | 10,310 | 5,155 | 36,086 | 31,575 | 644 |
| | São Paulo | -957 | -957 | 10,532 | 10,532 | 479 |
| **5.** | **Frostmeat Fleischandelsgesellschaft** | **106,053** | **26,717** | **170,258** | **111,761** | **2,580** |
| | Mato Grosso | 88,441 | 14,307 | 114,454 | 59,828 | 1,301 |
| | Goiás | 7,895 | 3,948 | 27,634 | 24,180 | 493 |
| | Mato Grosso do Sul | 10,453 | 9,199 | 20,070 | 19,652 | 418 |
| | São Paulo | -736 | -736 | 8,101 | 8,101 | 368 |
| **6.** | **Intervlees Nv** | **100,654** | **26,210** | **166,397** | **111,440** | **2,589** |
| | Mato Grosso | 81,998 | 13,264 | 106,115 | 55,469 | 1,206 |
| | Goiás | 8,894 | 4,447 | 31,130 | 27,239 | 556 |
| | Mato Grosso do Sul | 10,523 | 9,260 | 20,203 | 19,782 | 421 |
| | São Paulo | -793 | -793 | 8,718 | 8,718 | 396 |
| | Rio Grande do Sul | 32 | 32 | 232 | 232 | 11 |
| **7.** | **Eastfield Meat Ltd.** | **82,276** | **20,551** | **129,751** | **84,224** | **1,907** |
| | Mato Grosso | 68,913 | 11,148 | 89,181 | 46,617 | 1,013 |
| | Goiás | 6,070 | 3,035 | 21,244 | 18,589 | 379 |
| | Mato Grosso do Sul | 7,705 | 6,781 | 14,794 | 14,486 | 308 |
| | São Paulo | -412 | -412 | 4,532 | 4,532 | 206 |

| | | State-level average with deforestation | State-level average without deforestation | Stable pastures with deforestation | Stable pastures without deforestation | Imports (tonnes) |
|---|---|---|---|---|---|---|
| **8.** | **Fn Global Meat Bv** | **80,253** | **20,692** | **149,187** | **105,267** | **2,749** |
| | Mato Grosso | 65,397 | 10,579 | 84,631 | 44,239 | 962 |
| | São Paulo | -1,910 | -1,910 | 21,007 | 21,007 | 955 |
| | Goiás | 7,188 | 3,594 | 25,160 | 22,015 | 449 |
| | Mato Grosso do Sul | 9,578 | 8,428 | 18,389 | 18,006 | 383 |
| **9.** | **Merlo Ercole Srl** | **74,328** | **19,227** | **121,703** | **80,949** | **1,833** |
| | Mato Grosso | 60,414 | 9,773 | 78,183 | 40,868 | 888 |
| | Goiás | 7,210 | 3,605 | 25,235 | 22,081 | 451 |
| | Mato Grosso do Sul | 7,123 | 6,268 | 13,677 | 13,392 | 285 |
| | São Paulo | -419 | -419 | 4,608 | 4,608 | 209 |
| **10.** | **Egatesa** | **64,513** | **15,247** | **89,387** | **53,355** | **1,162** |
| | Mato Grosso | 57,472 | 9,297 | 74,376 | 38,878 | 845 |
| | Mato Grosso do Sul | 6,445 | 5,672 | 12,375 | 12,117 | 258 |
| | Goiás | 633 | 317 | 2,216 | 1,939 | 40 |
| | São Paulo | -38 | -38 | 420 | 420 | 19 |
| **11.** | **Casasco & Nardi A** | **58,102** | **11,327** | **97,196** | **62,327** | **1,499** |
| | Mato Grosso | 52,032 | 8,417 | 67,336 | 35,198 | 765 |
| | Goiás | 6,194 | 3,097 | 21,680 | 18,970 | 387 |
| | São Paulo | -652 | -652 | 7,167 | 7,167 | 326 |
| | Mato Grosso do Sul | 528 | 464 | 1,013 | 992 | 21 |
| **12.** | **Agro Co. Di Giuseppe Comparoni** | **50,261** | **9,268** | **87,465** | **56,883** | **1,435** |
| | Mato Grosso | 45,649 | 7,384 | 59,075 | 30,880 | 671 |
| | São Paulo | -845 | -845 | 9,292 | 9,292 | 422 |
| | Goiás | 5,456 | 2,728 | 19,098 | 16,710 | 341 |
| **13.** | **Montesano Canarias Sa** | **43,064** | **9,091** | **59,088** | **34,127** | **736** |
| | Mato Grosso | 39,688 | 6,420 | 51,361 | 26,848 | 584 |
| | Mato Grosso do Sul | 2,588 | 2,277 | 4,968 | 4,865 | 104 |
| | Goiás | 788 | 394 | 2,759 | 2,414 | 49 |
| **14.** | **Quabas Group** | **40,771** | **8,791** | **70,566** | **46,823** | **1,167** |
| | Mato Grosso | 35,519 | 5,746 | 45,966 | 24,028 | 522 |
| | São Paulo | -641 | -641 | 7,048 | 7,048 | 320 |
| | Goiás | 3,948 | 1,974 | 13,817 | 12,090 | 247 |
| | Mato Grosso do Sul | 1,945 | 1,712 | 3,735 | 3,657 | 78 |
| **15.** | **Meat Imp. Zandbergen Brothe Bv** | **38,225** | **11,934** | **63,271** | **44,186** | **1,071** |
| | Mato Grosso | 29,409 | 4,757 | 38,058 | 19,894 | 432 |
| | Mato Grosso do Sul | 7,909 | 6,959 | 15,184 | 14,868 | 316 |
| | São Paulo | -473 | -473 | 5,198 | 5,198 | 236 |
| | Goiás | 1,380 | 690 | 4,830 | 4,226 | 86 |

| | | State-level average with deforestation | State-level average without deforestation | Stable pastures with deforestation | Stable pastures without deforestation | Imports (tonnes) |
|---|---|---|---|---|---|---|
| **16.** | **Fritz Vieh Und Fleischhandel Gmb H** | **35,454** | **7,743** | **55,652** | **35,228** | **850** |
| | Mato Grosso | 31,668 | 5,123 | 40,982 | 21,422 | 466 |
| | São Paulo | -358 | -358 | 3,935 | 3,935 | 179 |
| | Goiás | 1,759 | 879 | 6,156 | 5,386 | 110 |
| | Mato Grosso do Sul | 2,385 | 2,099 | 4,580 | 4,484 | 95 |
| **17.** | **Jucarne Sa** | **35,289** | **5,935** | **47,945** | **26,262** | **579** |
| | Mato Grosso | 34,552 | 5,589 | 44,715 | 23,374 | 508 |
| | Goiás | 782 | 391 | 2,736 | 2,394 | 49 |
| | São Paulo | -45 | -45 | 494 | 494 | 22 |
| **18.** | **E. Jacobsen Gmb H** | **32,102** | **7,915** | **52,574** | **34,744** | **829** |
| | Mato Grosso | 27,043 | 4,375 | 34,997 | 18,294 | 398 |
| | São Paulo | -328 | -328 | 3,609 | 3,609 | 164 |
| | Goiás | 2,294 | 1,147 | 8,030 | 7,026 | 143 |
| | Mato Grosso do Sul | 3,093 | 2,722 | 5,939 | 5,815 | 124 |
| **19.** | **Gvfi Europe/International** | **30,466** | **5,603** | **48,387** | **29,886** | **706** |
| | Mato Grosso | 28,091 | 4,544 | 36,353 | 19,003 | 413 |
| | Goiás | 2,632 | 1,316 | 9,211 | 8,060 | 164 |
| | São Paulo | -257 | -257 | 2,823 | 2,823 | 128 |
| **20.** | **Jan Zandbergen Bv** | **30,151** | **5,509** | **46,744** | **28,461** | **678** |
| | Mato Grosso | 28,176 | 4,558 | 36,463 | 19,060 | 414 |
| | São Paulo | -259 | -259 | 2,850 | 2,850 | 130 |
| | Goiás | 1,989 | 994 | 6,961 | 6,091 | 124 |
| | Mato Grosso do Sul | 245 | 216 | 470 | 461 | 10 |
| 21. | Marfrig | 26,723 | 26,723 | 223,189 | 223,189 | 10,145 |
| | Rio Grande do Sul | 28,208 | 28,208 | 206,858 | 206,858 | 9,403 |
| | São Paulo | -1,485 | -1,485 | 16,331 | 16,331 | 742 |
| 28. | Princes | 18,524 | 18,524 | 135,845 | 135,845 | 6,175 |
| | Rio Grande do Sul | 18,524 | 18,524 | 135,845 | 135,845 | 6,175 |
| 152. | Bolton Group | -6,582 | -6,582 | 73,855 | 73,855 | 3,357 |
| | São Paulo | -6,661 | -6,661 | 73,275 | 73,275 | 3,331 |
| | Rio Grande do Sul | 79 | 79 | 580 | 580 | 26 |
| | **TOTAL** | **1,918,236** | **466,575** | **3,664,251** | **2,593,025** | **74,942** |

**Table 4:** *Rank of 20 European importers in Italy, the United Kingdom, the Netherlands, Spain and Germany with the highest estimated carbon footprints calculated using the state-level upper-average footprints (with deforestation). The table is ordered from largest to smallest estimated carbon footprints. The table also includes the estimated carbon footprints for Marfrig, Princes and Bolton Food due to their relevance to this study. The imports being considered here are only the ones from the top five states of origin in Brazil: São Paulo, Mato Grosso, Rio Grande do Sul, Goiás and Mato Grosso do Sul. See the methodology for a brief explanation about the different herd management systems, including stable pastures.*

# Annex 3: Estimated footprints by state of origin

## *Estimated carbon footprints embedded in European beef imports by state of origin*


**Figure 6:** *Estimated carbon footprints embedded in imports of beef into Italy, the UK, the Netherlands, Spain and Germany from São Paulo, Rio Grande do Sul, Goiás and Mato Grosso do Sul. The chart shows the state-level carbon footprints (light colours) and the hypothetical carbon footprints for each country of destination if all beef imports were linked to cattle farmed in stable pastures (dark colours). See annex 1 for the detailed data.*

## Annex 4: The Instituto Escolhas Emissions Footprint study[51]

The researchers expressed the carbon footprint of beef production in Brazil through the unit $CO_2e$, (CO2 'equivalent'), which gathers in one single unit the emissions of different greenhouse gases resulting from the different stages of beef production[52]. Using this unit, researchers calculated the carbon emissions for each kilo of beef produced, expressing the carbon footprint of Brazilian beef production as $kgCO_2e/kg$ of beef.

Instituto Escolhas researchers considered all activities directly related to beef production, including production of agricultural inputs, ranch operations, deforestation, slaughter, beef processing, and final transportation to the main consumer hubs. The authors considered consumer hubs to be the capitals of Brazilian states – for domestic consumption – and the main import ports in each continent – for exports. Instituto Escolhas' study did not consider the final use of the product in the calculations (that is, what happens with the beef after it reaches the consumer hubs). For exports, the researchers considered the GHG footprint of maritime transportation.

The stages of beef production included in Instituto Escolhas' study are:

- Pre-production: manufacture of fertilisers for pasture
- Production: soil management, land use change, chemical and physical processes related to herds, waste management, fertiliser application, and fuel use (machinery)
- Logistics: transportation between farms and slaughterhouses, and between slaughterhouses and consumer hubs
- Processing: electricity, stationary combustion (machinery), waste management

Instituto Escolhas' researchers calculated GHG emissions from deforestation based on the carbon stored in biomass (carbon stock) in each of the two biomes analysed by the study (Amazon and Cerrado).

| Biome | Carbon stock ($tCO_2e/ha$) |
|---|---|
| **Amazon** | 573.16 |
| **Cerrado – south** | 115.92 |
| **Cerrado – north (area of transition to the Amazon)** | 378.63 |

51 Instituto Escolhas' environmental impact study (in Portuguese) can be accessed at http://www.escolhas.org/wp-content/uploads/2020/01/Relatorio_Do-pasto-ao-prato_Pegadas_FINAL.pdf. An executive summary in English can be found at http://www.escolhas.org/wp-content/uploads/2020/01/From-pasture-to-plate-subsidies-and-the-enviromental-footprint-EXECUTIVE-SUMARY.pdf.

52 The GHGs considered in the study were $CO_2$, $CH_4$ (methane) and $N_2O$ (Nitrous oxide). These gases are typically associated with agricultural production. Instituto Escolhas converted $CH_4$ and $N_2O$ into $CO_2e$ (equivalent) using the 'Global Warming Potential' method provided by the IPCC. For more details, see Instituto Escolhas' full study.