1   **Behind the Cattle Industry: Modern Slave Labor Used to Produce Brazil's Beef and**

2   **Leather**

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9

10   **Abstract**

11   In this study we investigated the persistent problem of modern slave labor (MSL) in the cattle
12   industry in the state of Pará, Brazil. We identified key characteristics of cattle ranches
13   implicated in MSL and evaluated the efficacy of Zero-Deforestation Agreements in
14   preventing MSL in supply chains. We found properties on the "Dirty List" for MSL tend to
15   be larger, more forested, and faster at deforesting than other ranches. Additionally, we
16   discovered degrading conditions and debt bondage are the predominant MSL types in the
17   cattle sector. Our results show slaughterhouses avoid buying directly from properties with
18   MSL. However, cattle from Dirty List properties continue to enter slaughterhouse supply
19   chains through indirect suppliers, even those committed to Zero-Deforestation Agreements.
20   Overall, our findings reveal the complexity of addressing labor exploitation in opaque cattle
21   supply chains. Expanding monitoring and traceability systems, improving transparency, and
22   providing alternative livelihoods for at-risk workers are urgently needed. Public-private
23   collaborations show promise for strengthening enforcement and improving working
24   conditions in the cattle industry.

25   Keywords: forced labor, cattle tracing, supply chain transparency, slaughterhouse monitoring,
26   debt bondage.
27

1. Introduction

Globally, the International Labour Organization (ILO) estimates that nearly 17 million individuals are ensnared in Modern Slave Labor (MSL) within the private sector (ILO, 2022). In 2023, the Global Slavery Index and the Walk Free Foundation have drawn attention to Brazil's role in perpetuating modern slavery, especially in the clothing and livestock sectors (Walk Free Foundation, 2023). Research by the NGO Repórter Brasil (2021) revealed that, from 1995 to 2020, approximately 17,253 workers within the cattle industry were rescued from conditions akin to slavery, accounting for nearly one-third of all individuals freed from such deplorable circumstances in Brazil during this period. However, there are likely many more cases going undetected, as inspectors find it challenging to obtain information and rescue workers in remote areas where most deforestation occurs (Teixeira, 2021).

These figures underscore Brazil's cattle industry as a significant factor in the broader landscape of global agricultural exploitation, despite the challenges in assessing the full extent of the problem. Notably, environmental destruction and labor abuses are often intertwined in the Amazonian frontier (Alvarez-Berríos et al., 2021), yet this critical issue generally receives less international attention than forest destruction does (Teixeira, 2021).

Brazil's cattle sector has a troubled history of labor abuse that persists despite the Brazilian Penal Code has prohibited MSL since the 1940s. This history traces back to the 1970s, when government policies encouraged Amazon settlement by facilitating access to inexpensive agricultural and cattle ranching (Smith, 2016). The government's policies inadvertently created conditions that left poor workers vulnerable to exploitation, particularly on large cattle ranches (latifundios) (Damasceno et al., 2017). The combination of inadequate basic services in settlements, unproductive land due to insufficient infrastructure, and violent

52 conflicts between landless workers and landowners left these workers with few alternatives,

53 forcing them to accept exploitative working conditions on large cattle ranches.

54   Brazil's legal framework defining modern slavery has continued to evolve over the

55 years. In 1989, a 17-year-old named José Pereira was shot in the head when trying to escape

56 the rural property where he was kept captive and forced to work in Pará. This case became a

57 landmark case when, in 1994, José Pereira brought it before the Inter-American Commission

58 on Human Rights with the help of human rights groups, alleging forced labor and inhumane

59 conditions (Inter-American Commission on Human Rights, 2003). The case prompted labor

60 leaders in Brazil to reexamine the crime of "reducing someone to a condition analogous to

61 slavery" (Pinheiro, 2022). This reevaluation led to the creation of "dirty lists" (DLs) to name

62 and shame MSL violators. Additionally, the definition of MSL in Brazil's 2003 Penal Code

63 was widened to include forced labor, debt bondage, long working hours, and degrading

64 conditions. These measures have helped delineate and address persistent MSL in Brazil's

65 cattle sector.

66   Today Brazil's DLs (Decree 540/2004) identify employers practicing MSL to facilitate

67 the implementation of sanctions by companies or other groups that may want to disassociate

68 with firms or individuals who engage in such practices. Carried out under the authority of the

69 Ministry of Labor, the listing procedure usually begins with a complaint made by an

70 individual (anyone, including laborers or anonymous informants), followed by a field

71 inspection by a mobile unit for signs of labor violations. Employers found to have MSL are

72 added to the DLs for two years and may face consequences such as exclusion from public

73 financing and credit. Additionally, those who are on the DL may also face lawsuits, where

74 field inspection reports can be used as evidence of the defendant's criminal behavior.

75   Brazil's DLs have faced opposition from various sectors. In 2014, the Brazilian

76 Association of Real Estate Developers (ABRAINC) won an injunction from the Supreme

77   Court that prohibited the publication of the DLs and demanded that a special law be passed

78   by Congress before any future disclosure of a DL. This halted the publication of the DLs in

79   2015. However, in 2016, the Supreme Court overturned the injunction, and the Ministry of

80   Labor resumed publishing the DLs in March 2017.

81   Labor violations in Brazil's cattle sector have also received some attention within

82   international campaigns aimed to slow deforestation in the Amazon. Specifically, DLs were

83   incorporated into the Cattle Agreements (CAs), an initiative starting in the early 2000's in

84   which meatpackers and retailers pledged to avoid buying cattle from properties with

85   deforestation, embargoes, protected areas, or those listed on the DLs for MSL. The CAs

86   include two types of commitments: one is the Terms of Adjustment of Conduct (TAC) signed

87   with the Federal Prosecutor's Office (hereafter MPF-TAC) (Barreto et al., 2017). The MPF-

88   TAC is legally enforceable and a significant innovation to fight MSL in a sector with

89   historical high MSL rates due to the lack of prior regulations prohibiting slaughterhouses

90   from trading in cattle from DL cattle properties. The other CA was the "G4" voluntary

91   agreement signed between Greenpeace and Brazil's four largest meatpackers—Minerva

92   Foods, BRF, Marfrig, and JBS (Gibbs et al., 2016). In the case of employers that participate

93   of the CAs, they can also be exposed to consumer and investor boycotts.

94   CAs are innovative tools and research shows their impact in lowering deforestation

95   embedded in supply chains (Gibbs et al., 2016). These initiatives are in line with international

96   human rights and business standards, such as the UN Guiding Principles on Business and

97   Human Rights, which emphasize the responsibility of companies to respect human rights and

98   carry out due diligence in their supply chains. However, little is known about their impact on

99   MSL practices in the cattle supply chain. Existing literature primarily focuses on MSL in

100 Europe, Asia, and Oceania, resulting in a significant knowledge gap concerning the Americas

101 and Africa. Additionally, most studies use qualitative methods or descriptive statistics instead

102 of data-driven analyses (Alix-Garcia and Gibbs, 2017; Han et al., 2022; Mehmood et al.,

103 2022).

104 In this paper, we examine MSL within the cattle sector in Pará, Brazil, where over 30%

105 of MSL cases linked to Amazon ranching occurred between 2004 and 2016. We assess the

106 effectiveness of the DL as part of the CAs agreements in curbing labor abuses in the cattle

107 supply chain. Using archival research and spatial analysis, we investigate whether

108 slaughterhouses purchase cattle directly or indirectly from DL properties and if this behavior

109 varies based on the List's public availability. We also examine the characteristics of

110 properties accused of MSL in terms of size, forest cover, and deforestation rate. This paper

111 seeks to bring new knowledge about MSL in Brazil and address the following critical

112 research questions about the cattle sector:

113 (1) What are the characteristics of cattle ranches in Pará that were on the DLs due to

114 having employed workers in modern slavery conditions?

115 (2) Do slaughterhouses with CAs avoid buying from properties on the DLs?

116 Through extensive archival research, we compiled past DLs, inspection reports, and

117 legal cases to identify specific MSL practices by cattle ranchers, including debt bondage,

118 long working hours, and degrading conditions. Expanding upon the work of Skidmore et al.

119 (2021) and West et al. (2022), who linked property data to Animal Transit Forms (GTAs), we

120 also linked our DL-derived cattle properties to GTAs. This novel combination of archival

121 DLs with property and GTAs enabled comprehensive mapping of MSL geographies in Pará's

122 cattle ranching from 2004-2016. Our work uniquely leverages these integrated data sources to

123 shed new light on MSL incidence in the Brazilian cattle industry.

124 **2. Methods**

125   **2.1** Study Area

126   The Brazilian state of Pará, situated within the Amazon region, encompasses an

127   expansive 125 million ha, nearly twice the size of Texas (INPE/PRODES, 2021). Pará has

128   experienced substantial loss of its natural forest cover, with approximately 49.4 million ha, or

129   40% of its total land area, being cleared between 2008 and 2022 (INPE/PRODES, 2021). The

130   transformation of these formerly forested areas has primarily been towards anthropic land

131   use, with a striking 96% transitioning specifically into pastures, now spanning some 21.5

132   million ha statewide (MAPBIOMAS, 2021).

133   Pará's cattle industry reflects a legacy of labor exploitation dating back to colonial

134   slavery, with modern workers still facing similar harsh conditions for minimal or no pay

135   (Méllo & Gomes, 2008). This continuity highlights the lasting influence of historical

136   injustices on Brazilian agriculture. Currently, Pará holds a notable cattle population of nearly

137   21 million head, contributing a significant 10% to Brazil's total herd (IBGE, 2020). This

138   thriving cattle industry has given rise to 49 slaughterhouses, 43 of which processed over

139   5,000 heads each in 2022, as GTA data indicates. These slaughterhouses serve both domestic

140   and international markets, extending their operations to diverse consumer bases (O Eco,

141   2022). A striking fact emerges in that 83% of Pará's 2022 cattle slaughter occurred in

142   facilities participating in CA. Impressively, 65% of slaughterhouses processing over 5,000

143   heads were signatories, with cumulative output reaching 585,694 head across these plants in

144   2022 (IBGE, 2023).

145   **2.2 Data processing**

146   To conduct our analyses about the characteristics of properties that use MSL, we drew

147   from five major datasets:

148   a.) Inspection Reports from the Regional Labor Office (2006 - 2014) that detailed the

149   owner of the property, the type of production (e.g., cattle), the labor functions

150   performed by workers, and any labor regulations that were violated. We utilized the

151   Access to Information Law to access 31 inspection reports from Pará that were

152   associated with cattle activity. These reports were the only ones available at the time

153   of our research.

154   b.) The Ministry of Labor's DLs are released biannually and contain names,

155   identification numbers, addresses, and economic sectors of listed individuals. The

156   economic sector is classified using codes indicating the type of economic activity. By

157   looking up the codes at https://concla.ibge.gov.br/busca-online-cnae.html, it is

158   possible to identify listings associated with cattle ranching. However, the Ministry of

159   Labor's website does not provide all the DLs since their creation in 2004. To obtain

160   eleven of the DLs published online since 2004, we downloaded data in 2013 and

161   2018, and also relied on the efforts of organizations such as Repórter Brasil and

162   Globo (Business and Human Rights Resource Centre, 2013; Ferreira 2013;

163   Ecodebate, 2014; Reporter Brasil and Sakamoto, 2016). These institutions obtained

164   the lists through the Access to Information Act while its publication was suspended

165   between 2014-2017 or directly from the Ministry of Labor's website when outside the

166   suspension period, subsequently releasing the lists on their respective websites.

167   c.) Judicial decisions (2011 – 2020) in which DL cattle ranchers were tried in criminal

168   court on charges of "reducing someone to a condition analogous to slavery". We

169   accessed the court decisions through the Federal Court of Pará's website (trf1.jus.br),

170   which allowed us to identify the types of MSL practices involved, such as debt

171   bondage, long working hours, forced labor, or degrading working conditions. A total

172   of 62 judicial decisions were reviewed and the MSL practices were classified

173   accordingly. The time period of the data analyzed here was posterior to the time

174   period of the DL mentioned earlier, as judicial decisions typically follow the release

175   of such lists.

176   d.) Property boundaries. The Brazilian government maintains several different

177   property registries that contain georeferenced property boundaries for rural properties

178   in Brazil. The Rural Environmental Registry (CAR) which is publicly available, is a

179   federally managed cadaster that provides property boundaries, and for some states,

180   including Pará, owner names and producer identification numbers (INCRA, 2015;

181   Terra Legal, 2015; CAR, 2016; L'Roe et al., 2016). The CAR is an initiative that aims

182   to map and register rural properties for better environmental and land management,

183   and while it started as a state-level program, there is now a federal version called the

184   SICAR. SICAR is a national digital platform that registers and manages

185   environmental data for rural properties, such as land use, conservation areas, and legal

186   reserves. Terra Legal is another program that focuses on the Amazon region and seeks

187   to regularize land ownership and resolve land tenure issues for small-scale

188   landholders. We downloaded property boundaries from both the Pará CAR and the

189   SICAR. In addition, we downloaded property boundaries from the INCRA-SNCI,

190   INCRA-Sigef, and Terra Legal programs.

191   In some cases, different property registries contain different property boundaries for a

192   single property. For example, Terra Legal and SICAR may have non-matching

193   boundaries for a given property. We downloaded some registries multiple times over

194   a period of several years, since property boundaries can also change over time within

195   a registry. To address this issue, we ranked our property maps as follows: Terra Legal

196   was given highest priority, followed by INCRA (SIGEF or SNCI), and finally by

197   CAR (state or federal). Within these three categories, we ranked more recent

198   download dates higher than older download dates. For each property, we selected the

199   highest ranked property boundary. In some cases, a single property map can contain

200   multiple different boundaries for the same property. In these cases, we spatially

201   merged the boundaries associated with the same property within a single map using

202   the PostGIS ST_Union function.

203   e.) The Animal Transit Guide (GTA) data for the time period 2013-2018, which is

204   collected by a state agency and identifies cattle movements between properties and

205   slaughterhouses (ADEPARÁ, 2019).

206   **2.3 Three analytical levels and variables studied.**

207   Level 1.) Across Pará, we analyzed labor inspection reports, DLs, and judicial decisions

208   to tally the types of MSL that DL cattle ranchers engaged in (debt bondage, forced labor, long

209   working hours, or degrading working conditions). We used existing literature (Brito Filho,

210   2004, p. 13) to classify the types of MSL (Table 1). When labor inspection reports were

211   unavailable for DL cattle ranches, we relied on court decisions to determine the types of MSL

212   on the property.

213

214   **Table 1.** Types of MSL violations, as per Brito Filho 2004.

Type of MSL	Definition
Degrading working conditions	Lack of basic needs, such as potable water, housing, and food
Debt bondage	Employees are indebted to landowners and cannot leave until they pay off their debt
Forced labor	Employees are coerced into working through physical or psychological harm, including threats with firearms
Long working hours	Employees work excessively long hours that harm their health

215

216   Level 2.) Next, we focused on the subset of DL properties that we could map by cross-

217   referencing the names of producers and municipalities and the property boundaries data from

218   the CAR and other sources described in section 2.2. By identifying the location of DL cattle

219   ranchers, we were able to assess spatial characteristics, including deforestation rates,

220   remaining forest, pasture area, and the presence of protected areas or environmental

221   embargos. To calculate remaining forest and annual deforestation rates on properties, we used

222   INPE's 2018 PRODES Legal Amazon map (INPE 2019). To calculate pasture area on

223   properties, we used MapBiomas 4.1's 2018 map (MapBiomas, 2020). We evaluated whether

224   properties were located within protected areas using maps of conservation units (MMA,

225   2018) and indigenous areas (FUNAI, 2018; we excluded indigenous areas with a status of

226   "em estudo"). We obtained embargo data from lists and maps downloaded from the Brazilian

227   Institute of the Environment and Renewable Natural Resources' using website (IBAMA list;

228   IBAMA map). Our analysis was primarily conducted using R for MapBiomas data

229   processing and PostgreSQL database with PostGIS extension for handling other datasets and

230   calculations. This comprehensive approach allowed us to consider the environmental impact

231   of DL cattle ranchers.

232

233   Level 3.) Last, we linked those DL cattle ranches that were matched to property

234   boundaries to the GTAs (2013-2018) to track cattle sales to and from those properties. For

235   more information about linking GTA to property map records, see the Supplementary

236   Material of West et al. (2022). We used the GTA data to classify suppliers based on their

237   predominant transaction type. 'Direct suppliers' were those whose transactions mainly

238   involved slaughter, whereas the transactions of 'indirect suppliers' mainly involved sales for

239   transporting cattle to pastures or feeding lots to fatten animals prior to slaughter. We

240   compared the number of cattle transactions that took place while the DL was suspended

241   (from 2014 to 2017) and while it was published (the years 2013 and 2018). Considering that a

242   cattle rancher's name remains on the DL for two years, we analyzed cattle transactions that

243   occurred within two years of the Ministry of Labor's website publication of the DL. Using the

244   two-year period, we also examined whether there were cattle transactions during the time

245   when the publication of the DL was suspended. As a metric for counting, we use extra-

246   official publication on websites such as Repórter Brasil and Globo. We also analyzed

247   properties that had criminal lawsuits filed by the Federal Public Prosecutor's Office after

248   2009— the year the MPF-TAC was signed and when the slaughterhouses' prohibition to trade

249   cattle with properties that had criminal lawsuits began.

250   **2.4. Data limitations**

251   We encountered data limitations. We were unable to assess the types of MSL for all

252   properties on the DL due to missing inspection reports from the Ministry of Labor in Pará

253   While these 93 properties provide valuable insights into the types of MSL practices, they

254   represent a subset of the total DL properties, and the proportions of MSL types may not

255   necessarily reflect the overall distribution. We also faced difficulty in linking GTA data to all

256   DL cattle ranches, which could be due to underreporting, inaccuracies, or discontinuation of

257   business by the cattle ranchers on the DLs. Due to these limitations, our results may not

258   represent the full extent of cattle transactions from DL properties in Pará. Moreover, we did

259   not delve into the specific categorization of slaughterhouses aligned with CAs into federal,

260   state, or municipal establishments.

261

262   **3. Results**

263   **3.1 Pará has more cases of cattle ranching-related MSL than any other state.**

264   Based on our analysis of the eleven available DLs in Brazil from 2004 to 2016, we

265   identified 997 employers who engaged in MSL. Of these, 334 were associated with the cattle

266   sector and located in the Legal Amazon, and a subset of 255 of these employers came from

267   Pará's cattle sector (see Figure 1). While this finding is based on the available data, it's

268   important to note that there may be unreported cases or limitations in the DLs that affect the

269   total number of MSL cases identified in each state.

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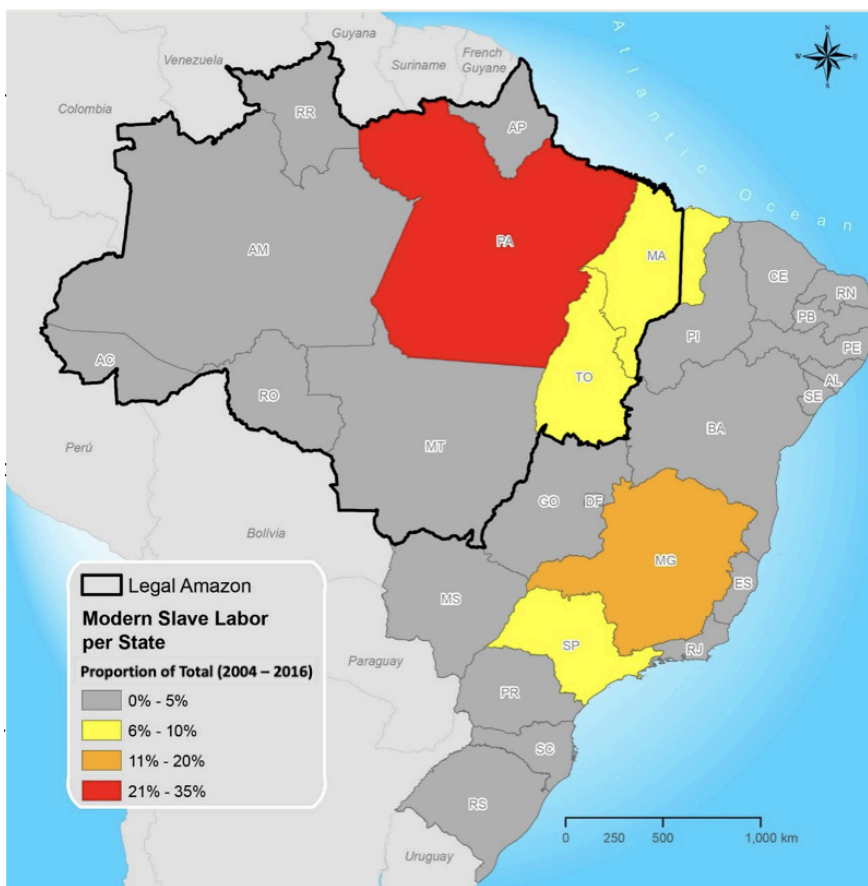
271

272   **Figure 1.** Pará accounts for the majority of cases of MSL associated with cattle ranching (2004-

273   2016).

274   **3.2 Degrading working conditions and debt bondage are the most prevalent types of**

275   **MSL faced by workers.**

276   We were unable to obtain additional information about the circumstances behind the

277   types of MSL in cattle ranches using labor inspector reports. To overcome this limitation, we

278   turned to judicial decisions for further insight. By doing so, we were able to gather more

279   information about the circumstances behind the finding of MSL for 93 out of the 255

280   properties on the DLs. For these 93, we identified a combination of degrading working

281   conditions and debt bondage in the majority of the cases (75% of the cases, see Figure 2).
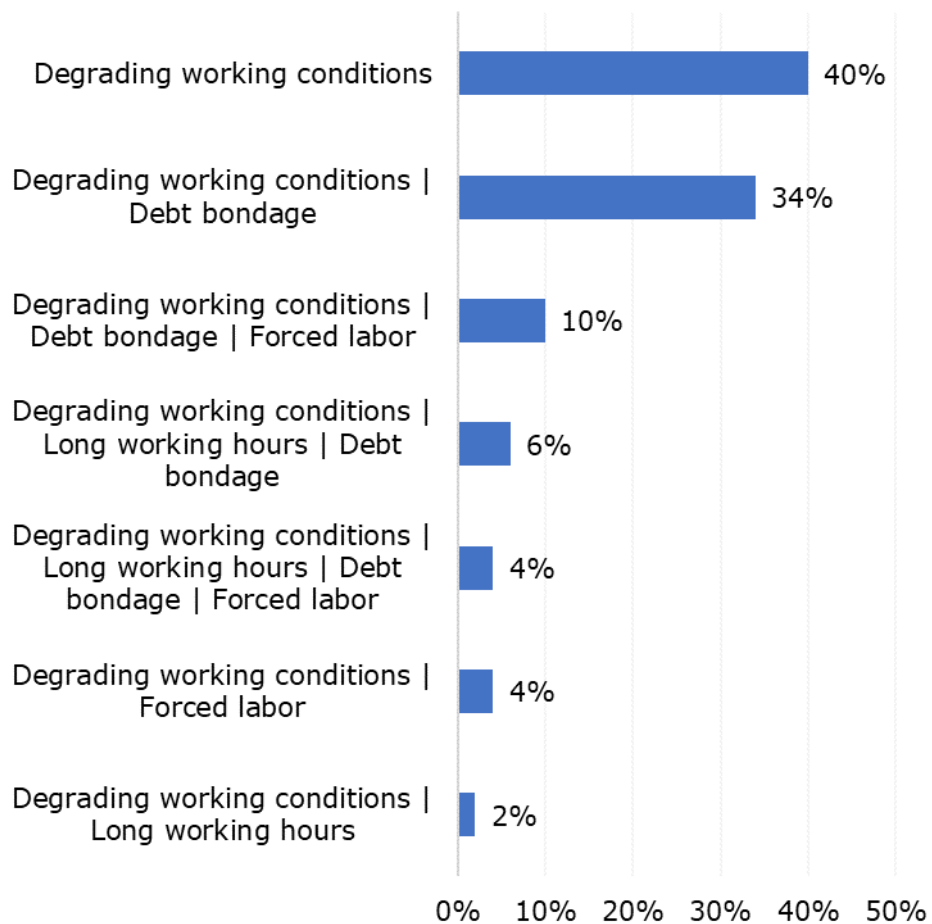
282

283   **Figure 2.** Main types of MSL identified in 93 properties on DLs in Pará (years 2004-2016).

3.3 Cattle properties on the DLs are larger and have higher deforestation rates than other ranches.

Of the cattle ranching employers on the DLs located in Pará (n=255), we were able to match 131 to specific cattle ranching properties using registries with property boundaries. We compared these 131 DL cattle ranching properties to all cattle ranching properties with pasture in Pará (n=1,055,000) in terms of property size, pasture cover, deforestation rate, remaining forest area, embargo status, and location within protected areas. The DL cattle properties are much larger and have less pasture than the average cattle properties. DL cattle properties average 2,839 ha, > 10 times the average of 265 ha of the non-DL cattle ranches. In terms of pasture coverage, on average, pasture covered only 52% of the DL cattle ranches, compared to 66% for all cattle ranches. The median size of the 131 DL properties is 1,150 ha while the median size of non-DL properties with pasture in Pará is 86 ha.

DL cattle properties also tend to have higher deforestation rates and more remaining forest. More than half the DL cattle properties (55%) had forest clearing between 2010-2018, with 43% having deforestation over 6.25 ha for that time period. Comparatively, only 43% and 28% of typical cattle properties in Pará had any or over 6.25 ha deforestation between 2010-2018, respectively. Of the DL properties with forest clearing, 93% exceeded the legal limits under the Brazilian Forest Code. Similarly, 97% of typical properties in Pará with any deforestation between 2010-2018 had cleared less than 80% of their property classified as primary forest cover based on PRODES - also surpassing legal limits. In addition, the DL cattle properties had a higher percentage of forest area remaining (36%) than the properties non-DL (25%). Moreover, only 2% of non-DL cattle properties were on the IBAMA embargo list at some point in time, compared to 10% of DL properties. Additionally, 5% of non-DL cattle properties were located within protected areas, while 10% of DL properties were situated inside protected zones.

309

3.4 CA slaughterhouses blocked purchases from DL direct suppliers.

Of the 255 employers listed in Pará, we were able to map 131 cattle ranches. Of these,

43 are direct suppliers, and 41 are indirect. We investigated whether slaughterhouses that

signed the CAs purchased cattle from DL or non-DL cattle ranches. We then contrasted them

with slaughterhouses that did not sign the CAs (non-CAs). The transactions from the 43

direct suppliers and 41 indirect suppliers represent only a fraction of Pará's estimated total

cattle transactions for 2013-2018. Thus, while our DL sample offers insights into

slaughterhouse behavior regarding properties with labor violations, it may not fully represent

the entire regional cattle industry.

The 43 direct cattle supplying properties sold cattle to 183 different slaughterhouses, of

which 19 were CAs and 164 non-CAs. We then looked at the behavior of these CAs and non-

CAs slaughterhouses between two periods: the DLs suspension period (from December 2014

to March 2017), when the DLs were not publicly available due to legal disputes, and the DLs

publication period (from March 2017 to December 2018), when the DLs were resumed and

updated. We used two indicators: the number of GTA transactions and the number of heads

of cattle purchased directly from DL cattle ranches. (See Table 2)

Table 2. Comparison of GTA transactions and head of cattle purchased by CAs and non-CAs slaughterhouses from direct suppliers within 2 years of the official publication of the dirty list on the Ministry of Labor's website and within 2 years of extra-official publications of the dirty list.

	CAs		No-CAs	
	Transactions	**Head Sold**	**Transactions**	**Head Sold**
All properties[*] (2013-2018)	655,960 (100%)	11,783,373 (100%)	457,766 (100%)	6,489,271 (100%)

Dirty List Suspension Period (May 2014 – March 2017)	2,601 (0.40%)	47,147 (0.40%)	443 (0.10%)	10,646 (0.16%)
Dirty List Publication Period (Period excluding May 2014 – March 2017)	180 (0.03%)	3,115 (0.03%)	332 (0.07%)	5,100 (0.08%)

331   *Including the estimated total cattle transactions in Pará for the entire 2013-2018

332   period that occurred in DL and non-DL properties.

333   After the publication of the DLs, CAs slaughterhouses reduced their purchases from

334   DL direct suppliers by 93% in terms of both the number of transactions and heads of cattle

335   purchased. In contrast, non-CAs did not reduce their purchases to the same degree, with their

336   transactions only dropping by 25% and heads purchased dropping by 52%, indicating that

337   they continued buying from DL cattle ranches even if at lower volumes. Specifically, during

338   the DLs Publication Period, purchases from DL properties accounted for 0.03% of total

339   transactions and head sold for CAs, while for non-CAs, these purchases represented 0.07% of

340   transactions and 0.08% of head sold. In conclusion, the DL's public availability may have

341   enabled CAs to honor their commitments by helping them detect and stay clear of the

342   suppliers on the list, as evidenced by the significantly lower proportion of purchases from DL

343   properties compared to non-CAs.

344

345   **3.5 DL cattle ranches sell more cattle through indirect suppliers.**

346   Next, we examined the aggregate cattle sales volumes of properties classified as direct

347   and indirect suppliers. Our classification was based on the prevalent transaction types among

348   these properties: 'direct suppliers' were defined by transactions associated with slaughter,

349   whereas 'indirect suppliers' facilitated cattle transportation to pastures or feeding lots prior to

350   slaughter. Our analysis reveals that the indirect suppliers have a much larger share and a more

351 dynamic supply chain than the direct suppliers (see Figure 3). The indirect suppliers sold over

352 8 times as many heads of cattle and had almost 6 times as many GTA transactions as the

353 direct suppliers over the entire period. This suggests that the properties caught using MSL are

354 mainly involved in the indirect supply chain of cattle to the slaughterhouses. Therefore, more

355 effective traceability and monitoring systems are needed to ensure that slaughterhouses do

356 not source cattle indirectly from DL properties.

(A) Cattle Heads (B) GTA Transactions
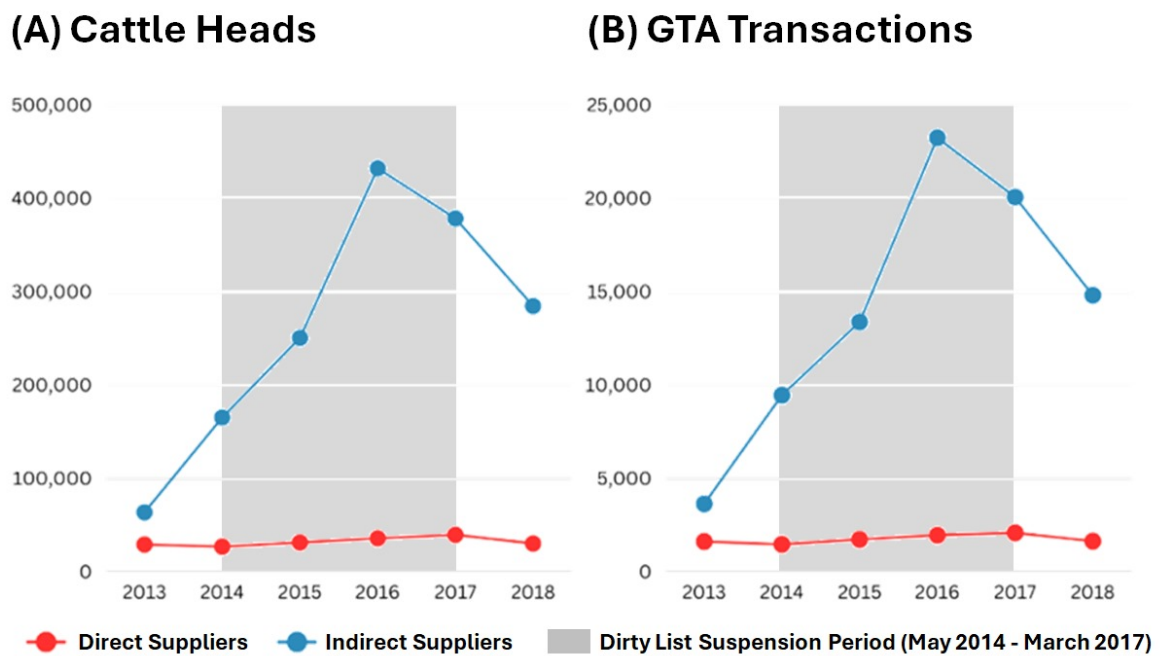
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358 **Figure 3.** Number of Head of Cattle and GTA Transactions by Year and Supplier Type for
359 Dirty Listed Properties.

360

361 **4. Discussion**

362   The importance of transparency and monitoring in addressing labor abuses in the

363 Brazilian cattle sector is further underscored by the evolving international standards on

364 business and human rights. In recent decades, organizations such as the United Nations and

365 the Organisation for Economic Co-operation and Development (OECD) have established

366 guidelines, such as the 2011 UN Guiding Principles on Business and Human Rights,

17

367 emphasizing the responsibility of companies to respect human rights and conduct due

368 diligence in their operations and supply chains. Brazil has gradually incorporated these

369 standards, as evidenced by the recent Bill 572/2022, which aims to make human rights due

370 diligence mandatory, aligning with similar legislation in France, Norway, Germany, and the

371 European Union. This international context reinforces the importance of initiatives like the

372 DL and CAs in increasing transparency and monitoring in the Brazilian cattle sector (Serva &

373 Faria, 2022).

374 At the national level, organizations such as Repórter Brasil and influential media

375 platforms like Globo continued reporting on MSL cases and the lack of transparency during

376 the DL suspension period. Their persistent coverage and use of the Access to Information

377 Law to obtain the unpublished lists kept public attention on this issue. Internationally, the

378 temporary suspension of the DL also drew criticism from organizations like the ILO and

379 media outlets concerned about labor rights and supply chain accountability in the Brazilian

380 Amazon. The Guardian newspaper (Douglas, 2016) emphasized that the DL was an important

381 tool for combating MSL, and its absence was criticized by activists and organizations such as

382 the ILO. This external scrutiny complemented the domestic pressure.

383 Our results highlight the challenges and possible importance of public disclosure of

384 MSL cases and CAs for reducing labor abuses from the cattle sector (Table 2). When the DLs

385 were publicly available, both CA and non-CA slaughterhouses decreased their commercial

386 transactions with ranchers involved in MSL, emphasizing the crucial role of transparency in

387 combating these abuses. During the period of suspension of the DLs publication, CA

388 slaughterhouses showed a greater propensity to buy cattle directly from listed suppliers,

389 suggesting a possible lack of effective monitoring or awareness-raising. However, when the

390 publication of the DLs was resumed, there was a notable change in behavior, with CA

391 slaughterhouses reducing direct purchases from these suppliers, indicating that public

392 availability influenced their purchasing decisions to comply with their commitments.

393   A decrease in transactions with 'contaminated' indirect suppliers was also noted after the

394 reinstatement of the Lists, even without direct monitoring. This suggests that CA

395 slaughterhouses exercise some level of due diligence in their supply chain, possibly as a

396 result of heightened awareness of the risks associated with purchasing cattle from properties

397 on the DL. However, even with a decrease in purchases from direct and indirect suppliers by

398 CAs during the DLs publication period, the slaughtered cattle continued to be contaminated

399 by MSL due to indirect sales from listed properties to direct suppliers. This finding highlights

400 the complexity of the supply chain in Brazil and the challenges in ensuring that suppliers do

401 not use MSL. It is crucial to improve monitoring, accountability of direct and indirect

402 suppliers, and expand CAs to the entire chain, implementing comprehensive traceability

403 systems.

404   Government-issued DLs provide transparency, but their continuous accessibility is

405 uncertain, as federal-level DLs have been suspended before. Hence, alternative and additional

406 information sources are needed to prevent cattle contaminated with MSL from entering the

407 supply chain. During the DLs suspension period, some institutions (e.g. Repórter Brasil) used

408 the law of access to information to obtain the list of people caught using MSL. Therefore, this

409 law can be used by interested parties to access the DLs, which still exist despite publication

410 suspension. Another pathway to obtain information about suppliers potentially using MSL

411 would be to access or request court records of ongoing lawsuits against suppliers accused of

412 using MSL on their cattle ranches. Moreover, voluntary industry statements could be vital to

413 ensure transparency. These systems, along with enhanced public-private collaboration, could

414 preserve visibility throughout the chain, using agile and redundant approaches, and thereby

415 sustain market pressure on MSL, despite political turbulence.

416   Our analysis shows debt bondage among Brazil's cattle ranchers intersects with other

417   serious abuses like denial of humane working conditions, rather than existing distinctly. This

418   co-occurrence indicates debt risks obscuring more egregious physical and psychological

419   mistreatments. It also reveals exploitative facets compound one another (Watts, 2021).

420   Crucially, all modern slavery manifestations, including debt bondage and deprivation of

421   essentials, violate human dignity and rights equally. Lacking basic necessities severely

422   impacts wellbeing. We underscore varied exploitations interact complexly, enabling an

423   interlinked system of abuse. Efforts must recognize their connections, not view debt or

424   conditions isolated.

425   DL cattle ranches in Pará tend to be larger and more remote than non-DL ones —

426   factors enabling ongoing exploitation per past research (Maisonnave & Gross, 2017).

427   Monitoring such vulnerabilities is critical. DL cattle ranches also tend to exhibit more

428   deforestation than their non-DL counterparts, often engaging in illicit activities such as illegal

429   deforestation and, possibly, land grabbing. Research suggests that workers are needed to clear

430   and prepare land for cattle grazing (Burberi, 2007; Jackson et al., 2020). Some ranchers

431   exploit MSL as a strategy to clear land and later claim ownership, illegally expanding the size

432   of their ranches (Repórter Brasil, 2003). The presence of remaining forested areas within

433   established properties should not be viewed as a risk factor for more MSL, but rather as areas

434   that require careful management to prevent illegal exploitation and deforestation. If these

435   cattle ranchers fail to treat workers with respect and dignity, MSL could contaminate the

436   region's cattle supply chain. Consequently, properties exhibiting high deforestation rates,

437   while still retaining forested and pasture areas, should be prioritized for intervention by

438   public and supply chain initiatives combatting MSL.

439   While our results provide important insights into the characteristics of cattle ranches

440   using MSL and the impact of the DLs and CAs, they should be interpreted with the

441 acknowledgment that data limitations may affect the representativeness of the findings.

442 However, our results offer significant implications for research and practice in addressing

443 MSL in Brazil's cattle sector. They help fill the research gap on MSL in the Americas,

444 provide a data-driven analysis of MSL features and dynamics in the cattle supply chain,

445 highlight the importance of addressing direct and indirect suppliers, and demonstrate the

446 positive impact when both public and supply chain initiatives, in this case the DLs and CAs,

447 work together. Based on our findings, we recommend the following for policy and practice:

448 strengthen enforcement and sanctions for MSL and deforestation in the cattle sector; improve

449 data availability and quality on MSL and deforestation; enhance supply chain transparency

450 and accountability; promote alternative livelihoods for workers at risk of MSL in the cattle

451 sector; and continue engagement with international organizations is crucial to strengthen

452 capacity and accountability in implementing these initiatives and aligning with global

453 standards on business and human rights.

454

455 **5. Conclusion**

456   This study offers significant contributions to understanding the persistence of MSL in

457 the Brazilian cattle industry, with a specific focus on the state of Pará. Our analysis reveals

458 that cattle ranches that use MSL tend to be large properties, with high rates of deforestation,

459 and predominantly exploit debt and degrading working conditions to exploit workers. We

460 also found that the slaughterhouses that signed the CAs avoided buying cattle directly from

461 known MSL perpetrators when the DLs were made public. Despite efforts to avoid directly

462 purchasing cattle from DL properties, contamination still persists through indirect suppliers,

463 representing an ongoing challenge in the cattle supply chain. Our results highlight the

464 significant impact of public disclosure of MSL data in reducing commercial transactions with

465 cattle ranchers involved in such practices, both for CAs and those without such commitments.

466 This finding emphasizes the crucial role of transparency and public access to information on

467 labor violations in the supply chain. These findings underscore the need to strengthen law

468 enforcement, transparency, traceability and coordinated initiatives to curb abusive labor

469 practices in the livestock supply chain. Slaughterhouses should strengthen their monitoring of

470 indirect suppliers, while regulatory bodies need to prioritize improving the availability of data

471 on MSL. Comprehensive solutions should also promote alternative livelihoods to prevent

472 worker exploitation. This research makes important contributions through its in-depth focus

473 on Pará, with an integration of archival and spatial data analysis methods, and an examination

474 of interventions by both public regulatory initiatives and private supply chains. It provides

475 valuable evidence to support targeted strategies that address the complex roots of MSL in the

476 cattle industry in the Brazilian Amazon. Future research can build on this work, expanding

477 the scope to other regions and agricultural sectors.

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