saúde EM DEBATE

ESSAY

‘Passing the cattle’: Repercussions of Brazilian livestock farming on human and environmental health

‘Passando a boiada’: repercussões da pecuária brasileira na saúde humana e ambiental

Stephanie Sommerfeld de Lara[1], Maelison Silva Neves[2], Simone Cynamon Cohen[3], Mariana Rosa Soares[2], Wanderlei Antonio Pignati[2]

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ABSTRACT Brazil is a global leader in the export of agricultural monocultures and beef, and the productive processes of this sector affect the health of populations in these territories. The objective was to describe livestock production in Brazil, state of Mato Grosso, and municipality of Cáceres, and to reflect on its repercussions for human and environmental health. An essay was conducted based on articles, official documents, and indexed databases, using the theoretical framework of the social determination of health and development surveillance. Results showed that pastureland exceeds the area planted with monocultures in Brazil; Mato Grosso has the largest cattle herd in the country and the highest number of fire outbreaks, as does Cáceres, which has the fourth largest herd and leads in water loss and wildfires in the state. Contamination by pesticides, particulate pollution, bacterial resistance due to antibiotic use, and climate change resulting from export-oriented agribusiness cause respiratory and cardiovascular problems, chronic pesticide poisoning, arboviral diseases, food insecurity, among others. Development surveillance must be incorporated into territories where economic production processes predominate, monitoring the environmental health harms that affect human health and seeking to transform and promote other forms of production that are healthy and sustainable.

KEYWORDS Environmental health. Rural health. Social Determinants of Health. Cattle. Agribusiness.

RESUMO *O Brasil é líder mundial na exportação de monocultivos agrícolas e carne bovina, entretanto, os processos produtivos desse setor afetam a saúde da população desses territórios. Objetivou-se descrever a produção pecuária no Brasil, Mato Grosso e município de Cáceres/MT, e refletir sobre repercussões na saúde humana e ambiental. Para isso, realizou-se um ensaio baseado em artigos, documentos oficiais e bases de dados indexadas, utilizando o aporte teórico da determinação social da saúde e da vigilância do desenvolvimento. Os resultados demonstraram que a pastagem supera a área plantada de monocultivos no Brasil; Mato Grosso possui o maior rebanho do País e os maiores focos de queimadas, assim como Cáceres/MT, possuindo o quarto maior rebanho nacional e liderando a perda hídrica e queimadas no estado. Contaminações por agrotóxicos, poluições por materiais particulados, resistências bacterianas pelo uso de antibióticos e mudanças climáticas oriundas da agropecuária de exportação ocasionam problemas respiratórios, cardiovasculares, intoxicações crônicas por agrotóxicos, arboviroses, insegurança alimentar, entre outros. Conclui-se que a vigilância do desenvolvimento precisa estar incorporada nos territórios onde os processos produtivos econômicos predominam, acompanhando os malefícios à saúde ambiental que repercutem na saúde humana, buscando modificar e estimular outras formas de produção saudáveis e sustentáveis.*

PALAVRAS-CHAVE *Saúde ambiental. Saúde da população rural. Determinantes Sociais da Saúde. Bovinos. Agroindústria.*

[1] Instituto Federal de Mato Grosso (IFMT) – Cáceres (MT), Brasil.
larassmt@gmail.com

[2] Universidade Federal de Mato Grosso (UFMT) – Cuiabá (MT), Brasil.

[3] Fundação Oswaldo Cruz (Fiocruz), Escola Nacional de Saúde Pública Sergio Arouca (Ensp) – Rio de Janeiro (RJ), Brasil.

Introduction

Land concentration in Brazil is marked by a long history of large latifundia held by a few, leaving little or no land for many. This is reflected in a reality in which less than 1% of agricultural properties hold nearly half of the country's entire rural area. Combined with an economy based on export-oriented agriculture and livestock production of commodity crops, this has entrenched the hegemony of agribusiness, especially in territories where this model predominates. Whereas Brazilwood, gold, and coffee once dominated, Brazil is now the world's leading exporter of soybeans, corn, sugarcane, and beef[1].

Subordinated to the logic of natural resource exploitation and wealth accumulation, agribusiness exercises domination across the moral, intellectual, political, and economic spheres – an ideology created and recreated within a set of institutions and social relations. Its logic can be seen in public financing policies, education, science, the practices of technical assistance companies, and even the activities of family farmers. The slogan 'agribusiness is pop, agribusiness is tech, agribusiness is everything' exemplifies this hegemonic notion that agribusiness is the source of wealth and essential to the lives of all Brazilians[2].

Considering this context is important from the standpoint of its totality within the health-disease process, since the scientific literature in the fields of health, work, and environment has shown that these productive processes have deleterious effects on the population's health profile, especially among rural populations, because their modus operandi causes environmental and social harm, such as contamination of the environment and of people by heavy metals from mining and dam failures; respiratory problems and mutilations in logging work, which is reproduced through fires and deforestation; and human pesticide poisoning and environmental contamination caused by agribusiness[3-6]. Some are more lethal than others, but all entail some degree of harm, which will manifest differently in each territory and social group, expressing themselves as embodiments of this social structure and this model of economic production[7].

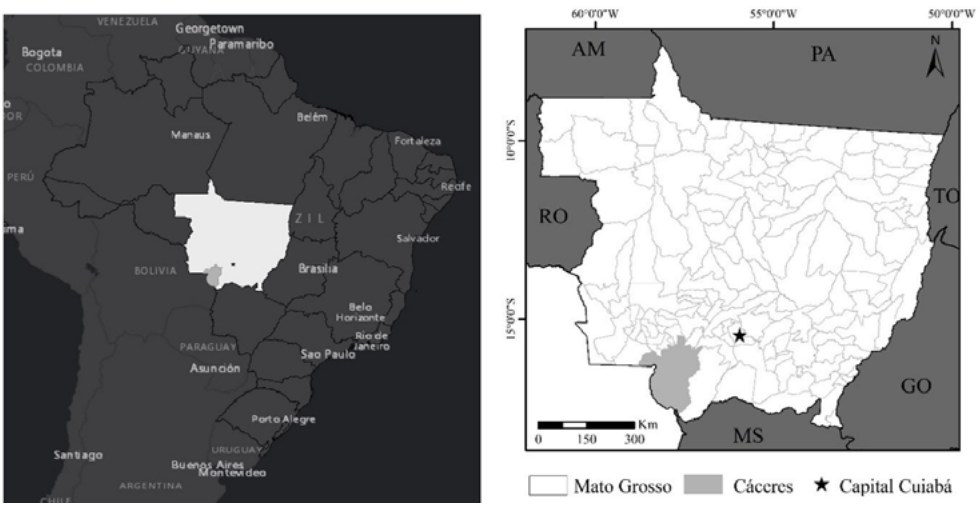
This is the main contribution and the most challenging aspect of the theory of the social determination of health. In seeking to grasp the complex health-disease process in populations, it dialectically coordinates biological and social, subjective and collective aspects, starting from the contradictory connections among structuring processes of social formations (political, economic, ecological), the specificities of territories and human groups, and the singularities of each concrete subject, without fragmentation or determinism[7,8].

The choice of agriculture/livestock production and of the territories under analysis is justified by the fact that this is one of the country's main economic activities, with Mato Grosso leading export-oriented agricultural and livestock production (soybeans, corn, and cattle), and Cáceres, Mato Grosso, the fourth-largest cattle producer in Brazil, earning the nickname Mato Grosso's 'cattle capital'[9,10]. Based on the foregoing, this essay aimed to describe the productive process of cattle ranching in Brazil, in the state of Mato Grosso, and in Cáceres, Mato Grosso, while reflecting on its repercussions for human and environmental health.

Material and methods

This academic essay is guided by the question, 'What are the harms of the cattle production process for human and environmental health?'. On that basis, cattle ranching was contextualized in Brazil, in Mato Grosso and in Cáceres, Mato Grosso, to broaden knowledge on the subject (*figure 1*).

Figure 1. Location map of the municipality of Cáceres/MT, state of Mato Grosso, Brazil



Source: Prepared by the authors based on the Cartographic Base of Brazilian Municipalities (IBGE)[11].

The criteria for selecting sources were based on the use of references recognized for their reliability, timeliness, and thematic relevance. Scientific articles were drawn from the following databases: Web of Science, Scientific Electronic Library Online (SciELO), Virtual Health Library (BVS), and the Journals Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES). In addition, we adopted books, documents based on official data – such as the 2017 Agricultural Census of the Brazilian Institute of Geography and Statistics (IBGE) and the 2023 Municipal Livestock Survey (PPM) – as well as publicly accessible information, such as MapBiomas and the Pasture Atlas of the Federal University of Goiás (UFG), all published between 2005 and 2024.

Tables were prepared in Excel® 365 and maps in ArcGis® 10.5 to display the data. The reflections were developed in light of Breilh's theory of the Social Determination of Health[7,8,12] and Pignati et al.'s Development Surveillance[13].

This essay stems from reflections developed within the doctoral program in Public Health at the Sergio Arouca National School of Public Health of the Oswaldo Cruz Foundation (ENSP/FIOCRUZ) and is nested in the project 'Promotion of Healthy and Sustainable Territories in Mato Grosso' (process no. 07/2020), conducted in partnership with the Federal University of Mato Grosso (UFMT) and the Labor Prosecution Office of the 23rd Region (MPT-MT).

Contextualizing the productive process of cattle ranching in Brazil, Mato Grosso, and Cáceres/MT: Cattle and pasture

The world's largest cattle herd, in number of head, is in Brazil, followed by India, the United States of America, and China[14]. According to IBGE[9], in 2023, the country had 238.6 million cattle heads, with the state of Mato Grosso leading the ranking with approximately 34 million head, followed by Pará with 25 million, and Goiás with 23.7 million. When categorized by municipality, the national ranking is led by São Félix do Xingu/PA, Corumbá/MS, and Porto Velho/RO (*table 1*).

Table 1. Ranking of the 12 largest cattle producers by state and municipality in Brazil, 2023

Ranking	State	Number of cattle heads	Municipalities	Number of cattle heads
1º	Mato Grosso/MT	33,994,004	São Félix do Xingu/PA	2,452,095
2º	Pará/PA	25,040,621	Corumbá/MS	2,150,382
3º	Goiás/GO	23,729,878	Porto Velho/RO	1,772,153
4º	Minas Gerais/MG	22,498,415	Cáceres/MT	1,399,931
5º	Mato Grosso do Sul/MS	18,891,916	Marabá/PA	1,305,000
6º	Rondônia/RO	18,162,632	Novo Repartimento/PA	1,275,779
7º	Bahia/BA	13,290,719	Vila Bela da Santíssima Trindade/MT	1,134,427
8º	Rio Grande do Sul/RS	12,012,219	Altamira/PA	1,079,168
9º	Tocantins/TO	11,313,309	Nova Mamoré/RO	1,042,736
10º	São Paulo/SP	10,768,360	Juara/MT	963,851
11º	Maranhão/MA	10,128,610	Colniza/MT	863,182
12º	Paraná/PR	8,774,410	Pacajá/PA	859,069

Source: Prepared by the authors based on the IBGE Municipal Livestock Survey data[9].

In the state of Mato Grosso, the largest herd is located in Cáceres/MT, with 1,399,931 cattle heads, placing it fourth among the municipalities with the largest number of cattle in the country[9,15,16]. According to the 2017 Agricultural Census, most of this herd is concentrated in non-family agriculture, as shown in *table 2*. Land concentration is also evident, with 23% of agricultural establishments in Brazil holding 77% of all agricultural land, and within them 69% of the country's cattle. The same pattern occurs in Mato Grosso, where 31% of agricultural properties hold 90% of all the state's agricultural land and produce 77% of its cattle. In Cáceres/MT, only 933 agricultural establishments concentrated 92% of the municipality's agricultural area, and within them, 80% of the cattle were found.

Table 2. Number of cattle heads, agricultural establishments and respective areas occupied by family farming and non-family farming in Brazil, Mato Grosso and Cáceres/MT, 2017

	Brazil	Mato Grosso	Cáceres
Family farming			
Number of cattle heads	53,607,594 (31%)	5,546,750 (22.8%)	154,842 (19.4%)
Number of establishments	3,897,408 (76.8%)	81,635 (68.8%)	2,603 (73.6%)
Agricultural area (ha)	80,891,084 (23%)	5,131,104 (9.3%)	126,555 (7.4%)
Non-family farming			
Number of cattle heads	119,111,570 (69%)	18,762,725 (77.2%)	644,739 (80.6%)
Number of establishments	1,175,916 (23.2%)	37,044 (31.2%)	933 (26.4%)
Agricultural area (ha)	270,398,732 (77%)	49,791,746 (90.7%)	1,590,799 (92.6%)

Source: Prepared by the authors based on data from the IBGE 2017 Agricultural Census[17].

Brazil is the world's largest exporter of beef, having exported approximately 2.536 million tons in 2023. Accordingly, because it has the country's largest herd, Mato Grosso leads Brazilian beef exports[18]. It is no coincidence that planted pasture has become the main land use in Brazil, covering 164.5 million hectares, corresponding to 19% of the national territory. Of all the land Brazil allocates to agriculture and livestock, 59% is pasture[19].

According to Alencar et al.[19], planted pasture area in Brazil increased by 82% from 1985 to 2023. The Amazon and Cerrado biomes concentrate 67% of this entire area, with 59 million hectares in the Amazon and 51 million in the Cerrado. The national dimension of this occupation is shown in *table 3*, which shows the area allocated to pasture according to Brazilian biomes.

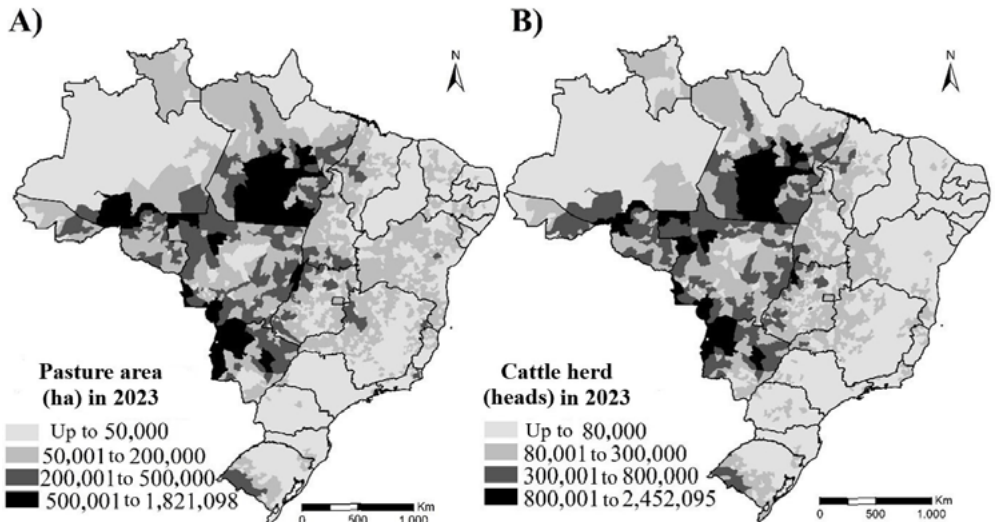
Table 3. Total area allocated to pasture in each biome of Brazil, 2023

Biome	Pasture in hectares	Comparison of pasture area by biome with the total pasture area in Brazil	Pasture area compared to the biome area	Pasture area compared to the agricultural area of the biome
Amazônia	59 million	36%	14%	88%
Cerrado	51 million	31%	26%	54%
Mata Atlântica	29 million	18%	26%	40%
Caatinga	22.9 million	14%	27%	70%
Pantanal	2.5 million	2%	17%	99%

Source: Prepared by the authors based on data from Alencar et al.[20].

Using 2023 pasture data made available by the Pasture Atlas[21] and cattle herd data for the same year compiled by IBGE[9], *figure 2* depicts the distribution and concentration of pasture and cattle in Brazil. The darker color gradient indicates the largest pasture areas per municipality (*figure 2A*), which correspond similarly to places with large numbers of cattle (*figure 2B*).

Figure 2. A) Map of land allocated to pasture in hectares and B) number of cattle by municipality and Brazilian state, 2023



Source: Prepared by the authors based on PPM-IBGE[9] and UFG[21] data.

As can be seen, land concentration in Brazil contributes to large areas being allocated to large-scale productive processes such as cattle ranching, with the opening of pastureland and cattle production, aided by climate and abundant water resources. This makes the country one of the world's largest cattle producers, ensuring high rates of profit and wealth concentration for the agrarian bourgeoisie, in alliance with the international monopolistic capital of food chains[22].

However, that is not all: the explanation for the profitability of this productive process also lies in the Kandir Law[23] economic policy, which, since 1996, has exempted primary products and goods destined for export from taxation, making the production of commodities such as soybeans, corn, and beef in their raw, unprocessed forms highly advantageous.

In politics, agribusiness entrepreneurs, including cattle ranchers, through the rural caucus – also known as the cattle caucus – also equip the state to secure public financing for their ventures and to relax environmental and labor legislation, thereby maintaining themselves as the hegemonic group and monopolizing political and economic power. According to Borracini[24], there is no evidence of effectiveness to justify subsidies for this sector, which means such financing represents an income transfer to a privileged segment of society, while family farming remains at the margins of state investment[25].

In addition, the rules and environmental legislation that protect life, fauna, and flora end up being regarded by these sectors as obstacles to the economic productive processes promoted in the country, to the point that a former Minister of the Environment used a global health crisis to weaken legislation.

> [...] the environment is one of the hardest areas in which to push through changes legally, in terms of infrastructure, regulations, and ordinances, because everything we do becomes a legal battleground the next day. So, this requires an effort from us here, while we are in this moment of calm regarding media coverage, because all anyone talks about is Covid, to 'let the herd through and change all the environmental rules', simplifying regulations from IPHAN, the Ministry of Agriculture, the Ministry of the Environment, from this ministry and that ministry. Now is the time to join

> efforts and push through the broad regulatory simplification that we need [...]. Ricardo Salles, former Minister of the Environment in 2020[26].

Despite the emphasis placed here, we should not overlook that the livestock production chain and the monocultures of soybeans and corn are part of the same agro-export and agro-industrial production matrix known as agribusiness. The territorialization of one productive form or another depends on geomorphological and climatic characteristics, namely: the Cerrado and Amazon flat areas witness a cycle of deforestation, cattle raising, and, in many cases, replacement of cattle by soybeans and corn; however, extensive cattle ranching persists in flooded areas (such as the Pantanal) and rugged terrain. In any event, these agribusiness productive arrangements expand at the expense of deforestation, fires, land grabbing, and environmental and occupational contamination by pesticides and chemical fertilizers[27].

Indeed, we cannot be ignore that the advance of agribusiness over the Amazon occurs through land grabbing and environmental crimes in a region that, by law, should be deforested in no more than 20% of its area[28], because it is essential to the planet's climate balance and the cradle of waters and flying rivers. In the case of Mato Grosso, Representatives and governors representing the agro-export elites who enrich themselves through environmental degradation proposed amending the State Environmental Code to reclassify part of the state's Amazon biome as Cerrado, since that would allow up to 65% of its area to be deforested under Bill Nº18/2024[29], which was later vetoed.

After the Amazon, the Cerrado is the largest biome in South America and is fundamental to the production, maintenance, and distribution of freshwater in Brazil, as it contains most of the headwaters of the country's main hydrographic basins and favors aquifer recharge due to the soil's high water infiltration capacity[30]. Nevertheless, intact vegetation in the biome has already been reduced to about 20% of its original cover because of the Brazilian Forest Code, which permissively allows up to 80% of its area to be cleared, making it one of the biomes most heavily exploited by agribusiness productive processes[31].

In Cáceres/MT, the expansion of pasture areas shows that the Pantanal biome is threatened by the development of cattle ranching, since a 182% increase in pasture area in the municipality was observed between 1999 and 2014[32].

Historically, the municipality of Cáceres/MT was an economic hub for cattle production since colonial times, with the purpose of feeding bandeirante expeditions that extracted gold in Cuiabá/MT and sent supplies to the former capital of the state of Mato Grosso in the 18th century, Vila Bela da Santíssima Trindade. The Jacobina farm, located 30 km from the municipality of Cáceres/MT, and Descalvados, 160 km away, relied on the enslavement of Africans and their descendants to produce goods derived from beef during that period[33]. Today, the municipality of Cáceres/MT is known as Mato Grosso's cattle capital, a title that reflects a productive process that has persisted since colonial times.

Recently, cattle ranchers in the municipality of Cáceres/MT demonstrated their power by revoking an amendment on the protection and defense of nature in the Municipal Organic Law in 2023[34], making clear the hegemony of agribusiness in political decisions in the territories where it is installed.

Repercussions of cattle ranching on environmental and human health

Health, as a field of knowledge and practice, cannot limit its actions to the surface of events, that is, to symptoms. It must seek the essence, the cause, and the generative processes that pressed for the occurrence of health harms and disease, including environmental transformations that negatively affect human health.

Breilh[35] refers to this process as embodiments, in which the manifestations of social

structure and its pressures are expressed in the biological sphere. Thus, based on the social determination of health theory, we understand that the process of becoming ill lies in the relationship between the subject and the social environment, without disregarding biology.

From this perspective, monitoring diseases without delving into the social determination of health means remaining unable to confront problems that transcend the individual and biological levels of health. For this reason, Development Surveillance, a theory proposed by Pignati et al.[13], is important as a praxis that articulates comprehensive health care across the different territories affected by diverse economic activities, in this case, cattle ranching. In this way of surveilling, care is coordinated with the mode of production, mitigating the externalities of capitalism.

> We define development surveillance as an intersectoral and participatory social policy apparatus that produces a territorialization of displacement grounded in the transformation of the economic bases of the agribusiness production chain's accumulation model into a mode of production structured around life cycles and the promotion of health in healthy and sustainable territories[13](356).

The urgency of development surveillance as a health surveillance strategy in the context of cattle ranching is justified by the environmental and health impacts of this productive process, which are not always visible but are nonetheless threatening to population health and to the environment, including at the planetary scale because of their contribution to climate change[13], as discussed below. When it comes to cattle ranching, this enormous herd goes largely unnoticed by the population because it is concentrated in rural areas, and so do the emissions of greenhouse gases (GHGs), residues of pesticides and antibiotics used in production; this is why it is important to present some data.

Cattle ranching is responsible for 14.5% of anthropogenic GHG emissions. Latin America and the Caribbean have the highest level of GHG emissions in the world, and one-third of these emissions come from beef production and the continuous expansion of pasture into forest areas and agricultural land for feed production. On the global stage, Brazil is the sixth-largest climate polluter from land use oriented toward cattle ranching[36].

In the livestock sector, 40% of emissions are generated by the digestive process of cattle, and another 45% come from the production supply chain (such as pasture, soybeans, corn, sugarcane, fertilizers, and liming), as well as feed processing and transport. Thus, beef protein is the commodity with the highest GHG emission intensity[36].

The state of Mato Grosso has the country's highest methane emissions due to its livestock production, totaling 2,136,881 tons, followed by the state of Pará, with 1,553,494 tons. Cáceres/MT ranked seventh among the largest emitters in Brazil in 2023, with 87,036 tons. Regarding carbon dioxide (CO2) and global warming potential (GWP-AR5), both in the state of Mato Grosso and in Cáceres/MT, the main emitting activity was land-use and forest change, making the state the country's second-largest polluter, followed by agricultural and livestock activities[37]. The herd destined for beef production remains the main source of emissions because of the number of animals, emitting eight times more than the dairy cattle sector, while in agriculture, the largest source of emissions corresponds to synthetic nitrogen fertilizers[38].

Polluting gas emissions from the agricultural and livestock production chain also include those resulting from fires. According to the National Institute for Space Research (INPE), in 2024, Mato Grosso ranked second only to Pará in the largest number of fire outbreaks, with 50 thousand and 56 thousand, respectively[39]. Cáceres/MT had the highest occurrence of fires in the state that year, and air quality reached levels exceeding by more

than 15-fold the particulate matter limits established by the National Environmental Council (CONAMA) Resolution and by the World Health Organization[40,41].

Regarding planted pastures in Brazil, 44% (72.6 million hectares) were affected by fire at least once between 1985 and 2023. The Amazon accounted for 68% of these fires, while the Cerrado accounted for 24%. In 2024, 34% of the area burned in the country had its onset detected in newly planted pastures less than eight years old, with about 40% of them burned[19].

Fires have been a major problem for both the environment and Public Health in recent years, and historically, fire has been used to create new areas for cattle ranching with planted pasture, as well as for pasture renewal or clearing, especially in extensive systems as a low-cost solution. In zones of recent agricultural frontier expansion, fire is used to open up land[42,43]. Brazilian legislation allows controlled burning in specific cases, subject to prior authorization by environmental agencies; however, most fires arise as criminal activity aimed at opening land, making more concrete judicial action necessary[44].

The contribution of cattle ranching and of its monocultures for feed to climate change and to harm to human health begins with the imposition of extreme heat, causing sunburn, skin cancers, malaise, ophthalmologic problems (pterygium), and circulatory issues, and extends to the proliferation of vectors that transmit arboviruses[45]. Fires used to clear and maintain pasture pollute the air with particulate matter, leading to respiratory and cardiovascular problems, especially among children and older adults[46,47].

Beyond pollutant emissions that contribute to the greenhouse effect, cattle ranching may pose a risk to national water security, since the water required to produce 1 kilogram of beef may range from 16 to 32 thousand liters[48]. Since the 2000s, a continuous reduction in water surface area has been observed in Brazil, according to the MapBiomas Água historical series from 1985 to 2023. Among the country's biomes, the Pantanal was the one that dried the most, and in 2023 its wet surface registered a level 61% below the historical average for that period[49].

The technical report from the Center for Studies in Health, Environment, Work, and Education (NEAST) indicated that, from 1990 to 2019, the municipality most affected by water loss was Cáceres/MT, with 250 thousand fewer hectares of water surface. It can be stated that, together, Cáceres/MT and Poconé/MT account for 76% of all the water surface loss in Mato Grosso, both located in the Pantanal biome and both focused on cattle production[50,51].

The replacement of forest areas by pasture and agriculture, as well as cattle overgrazing and trampling in river spring areas, affects entire ecosystems by compacting the soil, thereby reducing its capacity to absorb rainwater[52], while dams built to retain water for agricultural and livestock use can reduce river flow and increase water surface area in certain locations[53].

In pasture opening, chemical deforestation has also been used, as in the case of a criminal rancher who did this over an area of 81.2 thousand hectares in the Pantanal by aerial spraying of desiccant pesticides from the 2,4-D chemical group, which dried out native forest and opened the area for planted pasture[54,55].

In cattle ranching, herbicide-type pesticides are used on pasture, insecticides are used to control flies and ticks, and fungicides are used to control fungi[56]. A wide range of pesticides is also used in the production of monocultures that will become cattle feed, averaging 29 liters per hectare in cotton cultivation, 18 in soybeans, 10 in wheat, 7 in corn, and 5 in sugarcane[57]. There are no estimates of the quantity of pesticides used on pasture and cattle themselves, which could be useful for Public Health forecasting, especially given the vast agricultural and livestock area devoted to pasture and cattle in the country.

As a result of the chemical-dependent pesticide model in pastures, cattle, and crops such

as soybeans and corn, contamination by pesticides has been identified in environmental, human, and food matrices – foods, fish, rivers, sediments, water wells, rainwater, air, blood, urine, and breast milk – in regions where Mato Grosso agribusiness predominates[58-61].

Long-term population exposure to small daily doses of pesticides can trigger chronic poisonings with irreversible damage to human health, such as cancers and malformations, as well as acute and subacute poisonings[62-64]. Research has already shown that, in agribusiness regions, morbidity and mortality rates from cancer and fetal malformation are higher, as are pesticide poisonings, which also tend to be underreported[59,65,66].

In Cáceres/MT, a study conducted by Castro et al.[67] identified the presence of the herbicide pesticides thiobencarb and clomazone in the water of the Facão waterfall, which is surrounded by monoculture farms and cattle production. The waterfall is used for water supply by rural settlers and city residents, who seek it out for drinking as if it were mineral water. The embodiments of exposure to these pesticides may result in acute poisoning, neurotoxicity, hepatic and renal toxicity, and endocrine disruption[68].

Surveillance of Populations Exposed to Pesticides, Environmental Health and Air Quality Surveillance, Drinking Water Quality Surveillance, and the Pesticide Residue Analysis Program (Para) of the National Health Surveillance Agency are responsible for monitoring, overseeing, and mitigating environmental and human health impacts resulting from exposure to chemical, physical, and biological contaminants; however, they face major challenges.

There is a political lack of interest in making the negative effects of agribusiness visible because it is one of the country's main economic sectors, resulting in persecution of public servants, interruption of programs, underfunding, and obstruction of surveillance actions, in addition to distortion of results by shifting attention away from the causes of contamination and disease rooted in productive processes[58]. As a consequence, surveillance becomes limited to sample-based monitoring in a few impacted territories, with no capacity to transform the productive process or mitigate the harm caused. These issues will be revisited below in the discussion of development surveillance.

Beyond chemical contamination by pesticides, cattle ranching also triggers antibiotic resistance in human beings, and there is no Public Health program monitoring water quality in these cattle-producing regions. Vasconcelos and Silva[69] found scientific evidence that the indiscriminate use of antibiotics in agriculture, especially in cattle raising, transfers bacterial resistance to humans through multiple pathways, such as the food chain and environmental contamination from residues excreted by animals.

This occurs because antibiotics in agriculture and livestock production are used not only to treat disease in herds, but also as growth promoters, which involves the continuous administration of subtherapeutic doses. Humans may acquire resistant bacteria that cause severe infections, such as *Escherichia coli* and *Salmonella*, through consumption of contaminated foods such as meat, milk, and eggs, and rural workers may also be exposed through handling animals that can colonize or infect the human host, as well as contaminate the environment, water, and soil. Horizontal transfer of resistance genes may also occur – that is, pathogenic bacteria in the intestines of animals and humans exchange genetic material and begin to carry the resistance gene[69,70].

Another issue that affects human health is the concentration of land devoted to extensive cattle ranching, pastures, and monocultures that will become feed, biofuel, and export products. These uses compromise food production because they have reduced planted area, resulting in lower food availability in the domestic market and rising prices, thereby deteriorating food insecurity[71,72].

Climate change, with rising temperatures, altered precipitation patterns, and more frequent extreme events, adversely affect agricultural production by family farmers, who are responsible for producing most of the foods consumed in daily life[73,74].

As a result, we are not only exposed to destructive processes as a matter of individual choice and freedom; they are also imposed on us. In the cattle production chain, contamination of water, soil, and food, air pollution, drought, rising temperatures, altered rainfall regimes, pesticide-related diseases, and other harms are characterized as permanent, continuous, and inherent destructive processes within the mode of becoming[8,66]. Health surveillance must break through these logical barriers and incorporate development surveillance:

> The ethical horizon of development surveillance is the relocation of commodities to a secondary plane against t he reaffirmed centrality of developing human subjects under ecological conditions that expand possibilities for life through the satisfaction of their needs. It therefore stands in opposition to the un-development of real human needs[13(354)].

The current economic model, based on accumulation, productivism, and consumerism, is unsustainable given the finitude of the planet's resources, leading to degradation or loss of the organization of ecological systems and its residing communities. The dynamics and cycles of the creation, organization, reproduction, and maintenance of life are metabolized in a problematic way by society regarding nature, affecting human communities through countless social and ecosystem health impacts, whether local, regional, or global. It is, therefore, an unsustainable and unjust process[75].

Based on the approach presented and the reflections developed, we found that the sociohistorical, political, and economic relations structuring agribusiness and the livestock chain impose environmental, health, food security, and food sovereignty costs directly and indirectly on the population, all stemming from the current model of production and export.

Final considerations

The change in land use from native forests to vast areas destined for monocultures, pasture, and export-oriented cattle ranching has triggered ecological changes such as GHG emissions and rising temperatures, air pollution due to fires used to open and renew pasture, reduction of the area devoted to food crops, contamination by pesticides in environmental and human matrices, and bacterial resistance to antibiotics in humans due to indiscriminate use in cattle production.

Conversely, health services must deal with a range of harms and illnesses that could be prevented through a change in the agricultural and livestock production model toward agroecology and sustainable cattle ranching. Preventable causes include pesticide poisonings, congenital malformations, cancers, neurological problems, among others; antibiotic resistance, respiratory problems, circulatory problems, food insecurity, climate-related diseases such as arboviruses, among others.

In order to promote healthy and sustainable territories, it is necessary to invest in development surveillance, and not merely in disease surveillance, where capitalist economic productive processes are installed. Future studies should be conducted to estimate the population affected by the cattle production process. The common good must prevail over economically productive processes that negatively affect the environment, health, and society. Such processes must be environmentally sound, sustainable, and conducive to health promotion and human development rather than illness and social harm.

Authorship contributions

Lara SS (0000-0001-7996-1629)* contributed to the conception of the work, data collection, analysis and interpretation, writing and approval of the final version of the manuscript. Neves MS (0000-0001-9187-6283)* contributed to the writing, critical review and approval of the final version of the manuscript. Cohen SC (0000-0001-6228-6583)* contributed to the conception of the work and approval of the final version of the manuscript. Soares MR (0000-0002-0417-2614)* contributed to the critical review and approval of the final version of the manuscript. Pignati WA (0000-0001-9178-6843)* contributed to the conception of the work, critical review and approval of the final version of the manuscript. ■

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*Orcid (Open Researcher and Contributor ID).

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