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ESSAY

Agribusiness and health in the Cerrado and Amazon: Spatialization and acceleration of the spillover of new pathogens

Agronegócio e saúde no Cerrado e na Amazônia: espacialização e aceleração do transbordamento de novos patógenos

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ABSTRACT This essay analyzes the relationship between the expansion of agribusiness in the Cerrado and Amazon biomes and the emergence of new pathogens with epidemic potential. It begins with the discovery of new arenaviruses (Xapuri and Aporé) to discuss how territorial transformation promoted by soybean and sugarcane monocultures, enabled by state policies and financialization, creates ecological conditions favorable to the proliferation of wild reservoirs, such as rodents and bats. Landscape homogenization, deforestation, and the forced approximation between humans and wildlife increase the risk of disease spillover, such as hantaviruses and hemorrhagic fevers. The essay criticizes traditional epidemiological approaches and proposes an integrated reading that articulates the social determination of health, political ecology, and traditional knowledge, to face contemporary health challenges.

KEYWORDS Grassland. Collective health. One Health. Social Determinants of Health. Communicable diseases, emerging.

RESUMO *Este ensaio analisa a relação entre a expansão do agronegócio nos biomas Cerrado e Amazônia e a emergência de novos patógenos com potencial epidêmico. Parte da descoberta de novos arenavírus (Xapuri e Aporé) para discutir como a transformação territorial promovida pelas monoculturas de soja e cana-de-açúcar, viabilizada por políticas estatais e financeirização, cria condições ecológicas favoráveis à proliferação de reservatórios silvestres, como roedores e morcegos. A homogeneização da paisagem, o desmatamento e a aproximação forçada entre humanos e vida silvestre ampliam o risco de transbordamento de doenças como hantaviroses e febres hemorrágicas. O ensaio critica abordagens epidemiológicas restritas à história natural da doença e propõe uma leitura integrada que articule a determinação social da saúde, a ecologia política e os saberes indígenas, para enfrentar os desafios sanitários contemporâneos.*

PALAVRAS-CHAVE *Cerrado. Saúde coletiva. Saúde Única. Determinantes Sociais da Saúde. Doenças transmissíveis emergentes.*

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Introduction

In this essay, we propose a joint reading of recent events related to different pathogens (arenaviruses, hantaviruses, and coronaviruses) in the territorial context of the Cerrado and Amazon biomes in Brazil, drawing on a critique of the world-ecology of agribusiness, particularly soybean and sugarcane-ethanol chains, while highlighting the relevance of state policies in inducing the production of their geography. Through an interdisciplinary and inter-epistemic approach, we emphasize the epistemological and heuristic value of Indigenous cosmologies for dismantling these disease-producing territorial arrangements. Finally, we advocate a political-scientific agenda capable of supporting a science for the people through interinstitutional cooperation with diverse social and territorial movements in order to interrupt this destructive cycle for society and the environment.

The emerging Brazilian environmental and health crisis is a clear expression of ways of producing and living under capitalism, whose dynamics are deeply dependent on the State as a central agent in the financialization and territorialization of agribusiness. The impacts caused by soybean and sugarcane monocultures, enabled by public policies such as the Crop Plan and investments by the National Bank for Economic and Social Development (BNDES), reveal a structural collusion between destructive private interests and a patrimonialist State. This alliance produces an economic geography that homogenizes landscapes, eliminates sociobiodiversity, and imposes ways and rhythms of production that subordinate biomes, waters, and soils to the blind logic of accumulation and to its corresponding devastation and associated illnesses.

The emergence of zoonoses worldwide and in Brazil shows the direct link between land-use changes driven by agribusiness and the spillover of new pathogens. About 75% of emerging infectious diseases affecting humans originate in animals[1], in a context in which planet Earth is increasingly configured as a 'Farm Planet'[2]. Deforestation, forest fragmentation, and landscape homogenization, driven by extensive cattle ranching and soybean production, create 'simplified' ecologies and impose a forced proximity among workers, livestock animals, and wildlife. At agribusiness frontiers advancing over forests and savannas, monocultures and transport infrastructure (such as railways and intermodal terminals) create new biotic interfaces in which viruses such as hantaviruses, arenaviruses, and coronaviruses find ideal conditions to break free from the fragile yet complex multispecies web of cooperation that keeps them bound to wild zoonotic circulation.

In this context, deeply shaped by powerful economic and political dynamics synthesized in the social pact around agribusiness[3], approaches grounded in an epidemiology restricted to the natural history of disease, repackaged as One Health[4], prove incapable of understanding the etiology of complex sociobiological processes.

As it becomes more popular in Brazil, the One Health perspective increasingly crystallizes its political-epistemic role as an alleged mitigating agent of agribusiness itself. By naturalizing agribusiness modes of production (biome deforestation and ecological simplification, dependence on transgenic inputs, pesticides, genetic homogeneity, and so forth), One Health presents itself as a mere 'cost reduction' instrument[5], leaving health and social externalities in the blind field of corporate business economics for the State to solve and for society and the environment to bear. In light of the serious problems inherent in global industrial poultry production[6], it is striking that works such as those by Karklis's team, grounded in the One Health perspective, are incapable of calling this production model into question and can only offer responses in terms of 'cost reduction'. In such a conception, collective health becomes an attribute of the bankability of agribusiness: health and environmental solutions must pass through the

needle's eye of agribusiness financing itself, and whatever is not viable for agribusiness is not even considered to exist.

In contrast, this essay proposes an articulation between the Social Determination of Health (SDH), political ecology, and Indigenous epistemologies, through an interepistemic perspective that incorporates contributions from critical geography, political economy, and the cosmologies of Indigenous peoples such as the Mapuche. By recognizing the interdependence between social and biological events, surveillance practices based on attentive observation of landscape signals and care for territory become fundamental to interrupting the emergence of new pathogens.

For this reason, the collective production of a transdisciplinary and interinstitutional research agenda aligned with social and territorial movements[7] – such as those of Indigenous peoples, quilombola communities, and peasants who practice concrete forms of resistance to agribusiness – becomes central. Protecting the Cerrado, the Amazon, and their peoples, advocating for agroecology, and expanding sociobiodiversity are thus understood as primary strategies for health promotion and for preventing new diseases. A science of the peoples emerging from this perspective challenges hegemonic science to learn from popular surveillance practices in health and from Indigenous cosmopolitics, in tune with territory and with the diverse forms of materially producing life, considered within their multispecies web.

The virus and the Mapuche flower

The recent discovery, by researchers from the Oswaldo Cruz Foundation (Fiocruz)[8], of two new virus species in the family *Arenaviridae* in Brazil raises troubling hypotheses about their epidemiological potential. On a broader scale, these discoveries may help us reflect on the social production of health at a profound interface: is it possible to situate health and disease processes by coordinating the microbiological and molecular scale of pathogens with the transnational geography of soybeans, sugarcane, and industrial livestock production? How can the agribusiness-driven transformation of the Cerrado and Amazon biomes create the conditions for the emergence of new pathogens? Questions such as these demand responses across multiple dimensions, considering specific contributions from virology, geography, anthropology, economics, and ecology.

The study identified two new arenaviruses, Xapuri and Aporé, which, like other viruses in this family, find their natural reservoirs primarily in wild rodents. The viruses were identified in the municipality of Cassilândia, in Mato Grosso do Sul, in rodents of the species *Oligoryzomys mattogrossae* (known as the forest rice rat). Unlike Xapuri, Aporé belongs to clade B, which contains some of the arenaviruses most pathogenic to humans in South America, such as Junin virus (the cause of Argentine hemorrhagic fever), Machupo virus (Bolivian hemorrhagic fever), and Sabiá virus (identified in Brazil). Aporé is therefore genetically close to viruses with a high potential to cause severe hemorrhagic fevers in humans.

There are still no data on the Aporé virus regarding its capacity to infect humans, its pathogenicity, or the magnitude of its circulation in the country. As Lemos[9] points out, this discovery underscores the importance of continuous genomic surveillance to identify emerging pathogens before they become a public health problem, thus allowing the development of rapid differential diagnoses in cases of hemorrhagic fevers of unknown origin.

The epidemiological behavior of Aporé may resemble that of the Sabiá virus, also a clade B virus and the cause of Brazilian hemorrhagic fever. However, information about Sabiá virus is likewise scarce: since its discovery in São Paulo in the 1990s, only six human cases of Sabiá have been confirmed,

with four deaths, suggesting high lethality, although with sporadic and rural occurrence associated with work in forested areas and agricultural activities[10]. The natural reservoir of Sabiá remains unknown, but transmission is believed to occur through inhalation of aerosols from the excreta of infected rodents. It is reasonable to suppose that Aporé may behave like a 'Midwestern Sabiá': found in Cerrado rodents, with the potential to cause severe and sporadic cases of hemorrhagic fever in exposed rural populations, while remaining underdiagnosed because it is confused with endemic diseases such as leptospirosis, yellow fever, or even malaria.

Both Sabiá and the probable profile of Aporé indicate low transmissibility among humans, but they reinforce the need to include these agents in the surveillance and diagnosis of hemorrhagic fevers, especially in regions of expanding agricultural frontiers, where contact with wild reservoirs intensifies.

The region where the Aporé virus was identified, between Mato Grosso do Sul and Goiás, is intensively dedicated to agribusiness production, such as soybeans and sugarcane, and is crossed by grain-flow infrastructure, notably the Ferronorte Railroad, an important logistics network in the Brazilian Midwest. When I was in the region in 2012 to conduct an environmental impact assessment of the railroad, I was deeply struck by its ecological impact: trains pass by loaded with soybeans, which fall and accumulate along the edges of the railroad. Wild fauna become accustomed to consuming these grains in the face of fragmentation and elimination of Cerrado areas, which deprive them of foraging sources. I witnessed scenes of flocks of hundreds of macaws and rodents consuming soybeans scattered along the railroad margins.

The economic geography of the soybean complex extends far beyond the regional scale. Ferronorte is only one stretch of a larger network linking Rondonópolis, in Mato Grosso, to the port of Santos, in São Paulo, and from there to global markets, especially in Asia and Europe. The value chain of soybeans produced in Brazil is dominated by a transnational oligopoly that controls everything from inputs (seeds, fertilizers, and pesticides) to financing, trade, and processing. Production itself is conducted by large 'national' landowners, but they are vertically and financially integrated into major corporations.

The seed and biotechnology market is dominated by a few multinationals: Bayer-Monsanto controls transgenic soybean technology associated with the pesticide Roundup®. In December 2025, a widely cited 2000 study that minimized the carcinogenic effects of glyphosate, the active ingredient in Roundup®, was retracted[11]. Corteva and Syngenta complete an oligopoly so powerful that it can define prices and technical processes. Commercialization is likewise operated under an oligopoly by the group known as the ABCDs of soy (ADM, Bunge, Cargill, and LDC), to which the Chinese state giant COFCO has more recently been added.

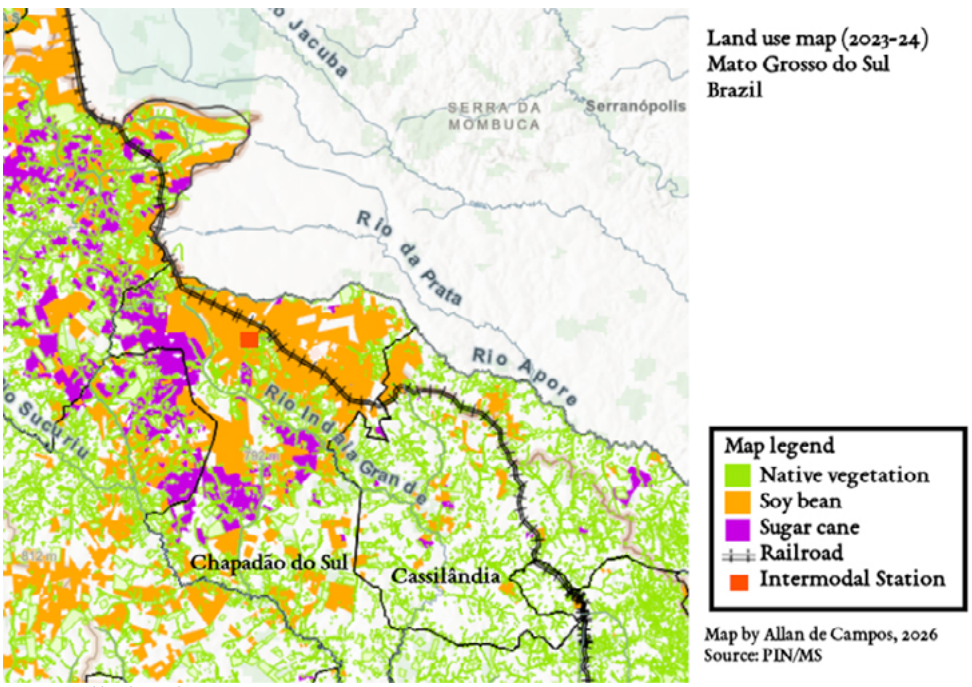
However, although the structure of the soybean market appears as a product of competition among companies and large corporations that little by little buy one another and produce mergers, its current oligopolistic morphology was enabled by a patrimonialist state policy and by the financialization of agriculture in Brazil and worldwide[3,12]. In other words, the Brazilian State guaranteed the economic conditions for the capital concentration we observe today, as well as for the transformation of soybean and sugar commodities into financial assets now traded in global markets. By way of example, the Crop Plan, which in 2025-26 exceeded BRL 500 billion, neatly encapsulates the social pact that unites State and civil society around agribusiness: the plan combines public investment (BNDES) with remuneration via private securities.

The study by Borges and Souza[13] shows that BNDES investments in agribusiness in Mato Grosso do Sul, directed toward the sugar-energy sector between 2001 and 2012, were substantial and focused mainly on expansion,

plant installation, and the purchase of machinery, totaling BRL 1.37 billion in the first period (2001-2008) and BRL 3.57 billion in the second (2009-2012). These resources are concentrated in the Southwest and East mesoregions of the state and enabled the installation of new production units owned by large corporate groups, especially in Rio Brilhante, Dourados, Nova Alvorada do Sul, Chapadão do Sul, and Costa Rica, resulting in a 464.55% increase in sugarcane-planted area between 2000 and 2012 and an increase in the number of mills from 8 to 22 in the same period. The study concludes that this dynamic of financialization, materialized by BNDES disbursements, was decisive for the expansion and consolidation of the sugar-alcohol sector in the state, profoundly altering land use and occupation, replacing food crops, intensifying landscape homogenization, and accentuating contradictions in the countryside by favoring the logic of monopoly capital and the transformation of land into a commodity.

The map below (*figure 1*) presents a summary of this territorial process. It shows sugarcane and soybean harvest areas, as well as remaining native vegetation in the northeastern region of Mato Grosso do Sul, where the municipalities of Chapadão do Sul, Cassilândia, and the Aporé River are located, the latter forming the border with the state of Goiás, where the virus of the same name was identified in a rodent. One can also visualize the Ferrogrão railway, which crosses both municipalities, as well as the intermodal terminal of Chapadão do Sul, to which trucks loaded with soybeans or sugar are directed in order to load train cars bound for the port of Santos.

Figure 1. Land-use map, Mato Grosso do Sul, 2023



Source: Prepared by the authors.

As can be seen on the map above, the area between Chapadão do Sul and Cassilândia is located precisely in a transition zone between sugarcane and soybean production and areas

with a greater occurrence of remaining native Cerrado vegetation. This is exactly the type of frontier between the homogeneous activities of agribusiness and natural reserves that favors contact between human populations and pathogen hosts. In addition, the very nature of grain and sugarcane production favors the loss of control over wild rodent populations, as we will see below. *Figure 2* below shows the intermodal terminal of Chapadão do Sul.

Figure 2. Chapadão do Sul road-rail intermodal terminal, Mato Grosso do Sul

Source: Mato Grosso do Sul Secretariat for Environment, Development, Science, Technology, and Innovation.

When biological diversity is reduced by deforestation and by the extensive conversion of native vegetation into agribusiness fields, natural predators (such as birds of prey, snakes, and predatory mammals) lose space, and rodent populations may grow abnormally. In Brazil, the advance of agribusiness over biomes such as the Cerrado and the Amazon, associated with the reduction of native vegetation areas that shelter predators, creates a risk backdrop for future rodent outbreaks. This scenario is deteriorated by a specific event: the displacement of deforestation, driven by the Soy Moratorium in the Amazon. While the voluntary agreement was effective in reducing direct conversion of Amazon forests into soybean cultivation after 2006, it does not apply to the Cerrado, which ultimately shifted the pressure of agricultural expansion to this biome[14].

Nevertheless, the Soy Moratorium shifted the problem of deforestation from forest clearing for grain production to cattle ranching: by blocking soybeans from newly cleared areas, the moratorium encouraged practices to circumvent controls, such as 'heating up' land, especially in the Amazon. Cattle ranchers began clearing land for pasture for a few years and thus simulating consolidated pastureland, only later to sell those areas for soybean planting, thereby legalizing the land under the agreement. According to MapBiomas, more than 90% of Amazon deforestation between 1985 and 2023 was for the opening of new pasturelands[15]. These data point to the complete ineffectiveness of the Soy Moratorium in stopping

Amazon deforestation. Still, the moratorium did serve a green-marketing role for sector corporations and thus helped legitimize the soybean chain.

Rodents, hantaviruses, and agribusiness

Wild rodents are also at the center of another virus family, much more common and widely studied in Brazil: hantaviruses, which cause hemorrhagic fevers. The team coordinated by Donalísio[16] analyzed the spatial distribution of hantavirus cases in the Cerrado biome in the state of São Paulo between 1993 and 2005, identifying the highest concentrations in the regions of Ribeirão Preto, São Carlos, Franca, and Tupi Paulista. The study revealed a clear seasonal pattern, with higher incidence during the driest months compared with the average of the preceding four decades. Donalísio associated this event with periods of greater food availability for rodents derived from grains, sugarcane, and other crops, highlighting that grain harvesting and storage increase human exposure to these animals.

Other studies on wild rodents, hantaviruses, and agribusiness in Brazil demonstrate a consistent relationship between monoculture expansion and increased risk of viral transmission. Recent spatial modeling studies published in 2024 confirm that agribusiness-driven deforestation in the Amazon and Cerrado favors generalist rodents such as *Necromys lasiurus*, projecting the expansion of hantavirus infection areas into dozens of new municipalities over the next decade[17].

Another study reveals direct associations between sugarcane production and increased risk of hantavirus transmission: sugarcane expansion alone would increase the average risk of Hantavirus Cardiopulmonary Syndrome (HCPS), placing 20% more people at risk. When combined with temperature-rise scenarios, the expansion in the number of municipalities at high risk would reach 7%[18]. In addition, Prist's doctoral dissertation, defended at the University of São Paulo in 2016, delved deeper into this analysis by showing that the risk of HCPS increased mainly with the proportion of land cultivated with sugarcane[19] in both the Atlantic Forest and the Cerrado of São Paulo.

In the Midwest, a seroepidemiological study published in 2023 in the journal Viruses by Maria's group at Fiocruz investigated the population of manual sugarcane cutters in the state of Goiás, the second largest producing region in the country[20]. Forty-four (6.9%) of the 634 workers tested for hantavirus antibodies showed seroreactivity, indicating previous exposure to the virus. The study described the epidemiological profile of cases reported in Goiás between 2007 and 2017, totaling 95 occurrences, and highlighted that manual sugarcane cutting increases the chances of human contact with infected rodents seeking food in sugarcane fields. About 70% of Goiás's territory is covered by the Cerrado, habitat of the rodent *Necromys lasiurus*, the most abundant host in this biome and one associated with Araraquara hantavirus, one of the country's most virulent strains.

This body of evidence points to the need to integrate climatic, ecological, and land-use variables into health surveillance systems, considering that agribusiness practices (such as no-till planting, maintenance of crop residue, and extensive monocultures) create ecological conditions that bring human populations closer to wild hantavirus reservoirs and, potentially, to other emerging arenaviruses such as the recently discovered Aporé.

Nonetheless, herein lies the limitation of conservative approaches in Public Health, still indebted to an epidemiology restricted to the natural history of disease and blind to the processes of the Social Determinants of Health. In this regard, contributions from geography and economics are fundamental for demonstrating how the financing arrangements that produce particular spaces and public-private financing circuits are configured, defining corporate

uses of territories tied to agribusiness's productive specialization and to its corresponding homogenization of landscapes. For geography, it is not enough simply to note that things are where they are. The concentration of rodent populations is a product of society's actions just as much as the location of an alcohol and sugar mill or a soybean farm.

Therein also lies the political-epistemological limitation of One Health approaches: beyond its conceptual genesis within the practices of agribusiness corporations, with companies such as Cargill and Colgate-Palmolive among its early promoters, One Health, like the epidemiology restricted to the natural history of disease, insists on shallow simplifications confined to the biomedical model of health[4]. Critically, it is necessary to complicate these models and think in terms of the Social Determinants of Health. If we fail to do so, we generally become operators of strategies of animal-welfarism and/or health-financial managers of agribusiness, incapable of calling its productive model and its technical-economic dependence on genetic monoculture – both in crops and cattle ranching – into question.

Opposition to this productive model, which we call agribusiness, must therefore forge alliances for sociobiodiversity. After all, even one of the pioneers of transgenic corn research, Norman Borlaug, came to understand that the elimination of biodiversity is an existential threat to humanity and began defending the creation of germplasm banks. Cunha[21], in turn, states that Indigenous peoples are collectors and therefore 'peoples of megadiversity'. Various studies show how the diversity of Brazilian biomes is directly related to landscape management by original and peasant populations, contrary to what a certain ecological conception based on the modern myth of nature untouched by humans would have us believe[22].

The Mapuche Indigenous people, for their part, offer a highly interesting counterpoint. Whereas the epidemiology of the natural history of disease tends to isolate pathogenic agents and seek linear causalities, Mapuche cosmology sees in the cyclical event linking the flowering of colihue cane (*Chusquea culeou*), native to South America, and *ratadas*, with population explosions of rodents feeding on the seeds, a manifestation of the interdependence among all beings inhabiting the *mapu* (territory). The synchronous flowering of colihue, which occurs at intervals that can reach 70 years, involves humans, rodents, predators, the forest, and the spirits that inhabit it[23].

This perception rejects metabolic rupture, the violent separation operated by capital between the nature's and social processes. For the Mapuche, when rodents proliferate, bringing with them hantavirus risks, this is a sign that a web of relations has been disturbed, demanding responses that reestablish another territorial web. By integrating the colihue cycle into their care calendar, the Mapuche practice epidemiological surveillance based on careful observation of landscape signals, in which producing health means precisely tending to the threads connecting the flowering of colihue, the movement of rodents, the presence of birds of prey, and the good living of the community. The Mapuche bring us a cosmological lesson that challenges the extractivist model to recognize that there are no disposable links in the web of life.

Darwin, Marx, and the bats

The advance of agribusiness over Brazilian biomes also profoundly disturbs bat populations, to which hundreds of new coronavirus species are associated. Brazil harbors the greatest mammalian diversity in the world, with about 178 identified bat species – many of which are recognized as natural coronavirus reservoirs. Anthony's team estimates that each bat species harbors between 2 and 3 different wild coronavirus species[24]; in other words, Brazil may harbor up to 500

wild coronavirus species, making the country the largest repository of wild coronaviruses in the world[25]. In short, few doubts remain about the possibility of coronavirus spillovers from bats in Brazilian biomes; however, the risk is amplified by a set of factors that includes deforestation, which fragments habitats and forces proximity among bats, human populations, and livestock animals. The expansion of agribusiness, which converts biomes into monocultures, and the constitution of precarious and semi-proletarian labor relations that expose workers daily to zoonotic risks, add important complicating layers.

Drawing on epidemiologist Wallace's[6] contributions about the Ebola epidemic (another virus whose natural reservoir lies in bats) in West Africa (2013-2016), we can build a critical analysis that sheds light, by analogy, on the risks posed by new bat coronaviruses in Brazil. The author affirms that the epidemic cannot be reduced to an accidental event or the chance contact between a child and an infected bat, the famous 'patient zero'. Wallace[6] thus proposes a structural reading: the outbreak was the acute manifestation of a more chronic process of economic and ecological transformation driven by neoliberalism in the West African region. The conversion of diverse Indigenous and peasant agroforestry systems into industrial monocultures of oil palm for export through corporate food systems, financed by international capital and enabled by structural-adjustment policies of local governments, created another ecological niche. This process attracted fruit bats, the natural reservoirs of the virus, to plantation zones, bringing them closer to semi-proletarian workers displaced by the same economic logic. Forest fragmentation and a homogenized agricultural landscape, by reducing the ecological complexity that had previously dispersed and contained outbreaks, allowed the virus to align itself into a continuous chain of contagion, transforming itself from a severe but rare disease into an agent capable of triggering a health crisis of regional and international proportions.

In both cases, in Brazil and West Africa, the driving force behind a potential emergence lies not only in the viruses but also in the way territory is produced. The expansion of monocultures over the Cerrado and the Amazon, the deforestation that fragments habitats, and the creation of mega-infrastructures follow the same script as the land enclosures and countryside proletarianization described by Wallace in Africa.

The 2013 Ebola epidemic in Africa is the product of the encounter between bat ecology and the political economy of oil palm. In turn, any eventual emergence of a new coronavirus in Brazil will need to be understood as a symptom of the agrarian-export development model and of the destruction of biomes that it imposes, requiring responses that far exceed vaccines or laboratories and that fundamentally include environmental protection and overcoming nature's commodification.

The case of Ebola within the political-economy webs of oil palm in Africa finds a structural parallel in the case of the Tembé people in the Brazilian Amazon. The company Brasil BioFuels (BBF) promotes large-scale oil palm monoculture in historically occupied territories, homogenizing landscapes to serve the global biofuel market. A report by Pajolla[26] details the chains of vulnerability linking this ecological reconfiguration to the emergence of disease: deforestation eliminates biodiversity and creates imbalances with insect infestations and the disappearance of predators; chemical contamination from pesticides and the disposal of *tiborna* (a chemical residue from palm oil production) harm human and animal health; and the destruction of gardens and forests forces Indigenous people to live at the edge of plantations, creating an ecological interface in which the virus does not need to 'invade' the village. Thus, the logic of agribusiness has repositioned the epidemiological frontier of zoonotic spillovers within community territories.

In the same report, the statement by Indigenous leader Urutaw Tembé about

'sustainability stained with blood' reveals two dimensions of violence: the physical violence against Indigenous bodies and the silent violence that prepares the ground for future health crises[26]. The 'Palm War' in Pará is thus the very 'factory' of pandemic risks in operation, recreating the same conditions that transformed Ebola from a forest virus into a devastating epidemic in Africa. The Tembé struggle for clean water, land to plant, and an end to poison is, therefore, a struggle to prevent the next pandemic. This struggle shows that protecting the forest and Indigenous and peasant territories is a central matter of Collective Health and its most fundamental form of health surveillance. This means that capitalist circuits of agribusiness production, through monoculture and territorial violence, align the conditions for the emergence of new pathogens along the very chains of socioecological vulnerability from which they first arise.

Finally, sequencing analyses of bats and coronaviruses show that they share entire segments of genetic material[27]. In other words, bats and coronaviruses have shared the same multispecies web over millions of years of evolution. As Darwin[28] foresaw, nature weaves relations of codependence at temporal scales more than human: in the case of bats, their singular physiology (such as flight and longevity) selected immunological mechanisms that allowed coexistence in dynamic equilibrium, integrating viral segments into host genomes as molecular fossils of a remote past.

The deep temporality of evolution, however, has been abruptly run over by the acceleration imposed by the time of capital, just as Marx described when analyzing how capitalism subordinates the time of life to self-valorizing value[29], synchronizing millennial biological processes to the rhythm of destructive production on a planetary scale. Deforestation, mining, and the conversion of forests into commodities rupture the webs of coevolution that kept viruses confined to wild cycles, forcing encounters in new interfaces where slow, cumulative biological time is replaced by the circulation speed of the biologically simplified commodities of agribusiness.

New pathogens may emerge in the fissures of this encounter between asynchronous temporalities, from agribusiness's annual harvests to their corresponding viral harvests. Another crystal-clear example of this dynamic can be seen in the evolutionary dynamics of highly pathogenic avian influenza (H5N1), burning through barns and livestock-production fields and reaching migratory birds even in places where the virus had never before been recorded, including Brazil[30]. Once rare events in natural history, epidemics, pandemics, and syndemics have become permanent systemic risks. Yet we still have time to learn how to read, in the molecular entrails of viruses and through the lens of agribusiness' transnational geography, the sociobiological mechanisms that cause new diseases to emerge, and thus interrupt the cycles of devastation and illness.

Final considerations

The emergence of new pathogens runs up against another problem, this one of an eminently political nature: the troubling scarcity of data and the serious limitations of the current Brazilian epidemiological surveillance structure, especially regarding monitoring emerging pathogens with epidemic potential, such as the new arenaviruses Xapuri and Aporé. Beyond them, however, we lack even minimal information on ecological dynamics at agribusiness frontiers within Brazilian biomes.

On the other hand, noteworthy is that public agricultural research agencies have for decades worked to develop more productive variants of chicken, sugarcane, or soybeans, prioritizing agribusiness and its productive chains to the detriment of a Collective Health system that integrates environmental, territorial, and social surveillance. The lack of consistent data serves to maintain a productive model that does not want to be disturbed by its own health externalities.

Confronting this setting requires the collective production of a transdisciplinary and interinstitutional research agenda aligned with the people who practice concrete forms of resistance to agribusiness. As exemplified by the Tembé struggle against oil palm monoculture in Pará and by Mapuche knowledge about the relations among bamboo flowering, *ratadas*, and hantavirus, a truly critical epidemiology has become capable of perceiving the signs of rupture in territorial webs. Incorporating these epistemologies into scientific research means breaking with the hegemonic logic that reduces health to a financial cost and beginning instead to recognize the protection of sociobiodiversity and Indigenous cosmopolitics as primary strategies for health promotion, fundamental to disease prevention.

For all these reasons, the collective construction of a 'science of the peoples' becomes necessary – a science of struggle[31] that challenges hegemonic science to learn from popular health surveillance practices, toward a vigilance attuned to territories, multispecies relations, and the rhythms of the landscape. Such a 'science of the peoples' would be more concerned with 'making kin' epistemologically and politically, to borrow Haraway's expression[32], than with closing ranks with forms of inhabiting the world that are as productivist as they are destructive.

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Authorship contributions

Silva ARC (0000-0002-6077-1435)* is responsible for preparing the manuscript. ■

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