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The Environmental degradation of the Cerrado: Unraveling the impact of Fast Fashion's Cotton Supply chain

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ABSTRACT

To cater the growing demand for affordable, short-lived apparels, the fashion industry has adopted a cost-driven strategy known as "fast fashion", which has not only revolutionized consumers accessibility to trendy clothing but also has inflicted severe environmental consequences, particularly in the ecologically sensitive regions like Brazil's Cerrado biome. In this study, we explore the intricate link between the fast fashion supply chain and the environmental degradation in Cerrado, which emphasizes the role of cotton production in deforestation, loss of biodiversity and water contamination. It also highlights how unsustainable monoculture practices and illegal land use, compounded by inadequate supply chain transparency from major brand like H&M and Zara have exacerbate ecological and socio-economic issues in the region. The paper underscores the urgent need for global accountability, stricter policy enforcement and awareness to safeguard one of the world's most biodiverse biome from irreversible damage.

Keywords: - Fast Fashion, Cerrado biome, Cotton production, Deforestation, Monoculture practices, environmental degradation.

1. INTRODUCTION

When discussing Brazil's environmental treasure that needs to be protected, the global spotlight is often the Amazon. Nevertheless, Brazil is home to other critical ecosystems, with Cerrado standing out due to its biodiversity value and the ecosystem services it provides to the entire region. Anthropogenic pressures on vegetation resources, particularly through the conversion of natural habitat into agricultural land, have been the primary driving force of the Cerrado biome since the past decades. The Cerrado is a vast Neotropical region of tropical savanna located in the eastern Brazil, covering an area of approximately 203 million hectares (Anache et al., 2018)

,representing 20% of Brazil's land area (Falca`o, 2020) and second-largest biome after Amazon rainforest (Silva&Bates, 2002). Known for its unique vegetation, sprawling grasslands and rich wildlife, Cerrado plays a critical role in the global ecological balance. It serves as a carbon sink, houses a staggering 5% of the world's diversity, and a vital water resource for major South American river system (Klink CA, 2005). Despite being a biodiversity hotspot, it faces relentless degradation due to its agricultural expanse, industrial practices and urbanization, threatening its fragile ecosystem. While civil groups and scholars have called attention to the ecological importance of Cerrado and the dangers it has faced due to global agricultural expanse, the center of Brazil has made many headlines as an agricultural powerhouse, producing crops for international market. (Whitepaper, 2024)

In the last two decades , the Cerrado was responsible for over 60% of total Brazilian production of cotton, soy and sugarcane (Arima, 2011).However, this level of production came at high price- the biome has lost 50% of its native vegetation as 30 million hectares were converted over the past 20 years (WWF, 2021).

At the same time, the global fast fashion industry has emerged as a dominant economic force, driven by consumer demand for affordable, trend-focused clothing. Characterized by rapid production cycles, high-volume manufacturing and short-lived product lifespan, fast fashion thrives on intensive resource extraction and exploitative supply chain (Fletcher, 2013).

While much of the critique of fast fashion has centered on human rights abuses and textile waste, its environmental consequences remain underexplored, particularly its indirect but profound impact on ecosystems like Cerrado.

This paper seeks to uncover the hidden links between fast fashion industry and the environmental degradation of Cerrado. The industry's demand for raw material especially cotton and leather, drives deforestation and land-use changes in the biome (Arima, 2011).The rapid conversion of biome into monoculture plantations not only threatens biodiversity but also contributes to climate change and water scarcity, underscoring the far-reaching consequences of seemingly disconnected industries.

(Source: Cerrado landscape, VectorStock)

2. FAST FASHION'S COTTON SUPPLY CHAIN

2.1 Overview of Cotton production

The Cerrado, Brazil's expansive savanna biome, underwent a significant transformation during the late 20th century, evolving as a central hub for cotton (*Gossypium hirsutum*) production. In 1990, most of Brazil's production took place in the South and Southeast regions. Since then, cotton production has shifted to Brazil's interior. Mato Grosso and Bahia accounts for about 80 percent of Brazil's cotton production. Mato Grosso and the major cotton-growing areas of Bahia lie within the vast area of the Cerrado, which consists primarily of savannahs and grasslands and occupies 197 million hectares, or about 23 percent of Brazil's land (JamesKiawu, 2011).

The shift towards Cerrado, catalyzed a decline in cotton productivity in traditional regions like São Paulo and Paraná. This decline was attributed to several factors, including the boll weevil pest crisis, market competition, and policy changes (kleinH&LunaF, 2023). The availability of vast expanses of inexpensive land in the Cerrado, combined with advancements in mechanization and irrigation, attracted farmers to relocate their operations. States such as Mato Grosso emerged as key players, establishing expansive cotton farms spanning thousands of hectares (kleinH&LunaF, 2023).

Although soil conditions in the Cerrado were initially very poor, advances in soil technology and development of new crop varieties have enabled higher cotton yields in the region. Brazil's cotton yield, which remained mostly flat from 1960 until the mid-1990s, began to rise rapidly after 1996-97 (JamesKiawu, 2011).

Cotton yield in Brazil have risen the fastest of major world producers in recent years. With the adoption of modern, large-scale farming and improved access to inputs, and due to the extremely favorable climate, Brazil's cotton yields have surged to more than double the world average. Today, Brazil's average yield is second only to those in Australia and Israel, where production is almost entirely irrigated. Brazil's 2009-10 cotton yield is estimated at 1,498 kilograms per hectare, only 14% below yields in Australia and Israel. (USDA, 2010)

By the early 21st century, the Cerrado became the backbone of Brazil's cotton industry, accounting for the majority of production. The integration of modern farming techniques, high-yield seed varieties, and large-scale mechanization positioned Brazil as the world's second largest cotton exporter. However, this transformation came at a cost. The expansion of cotton farming in Cerrado led to significant environmental impact (kleinH&LunaF, 2023).

2.2 The Rise of Fast Fashion

The connection between cotton production in the Cerrado and the fast fashion industry began to solidify in the early 2000s as the global fashion industry expanded, driven by the rise of fast fashion brands. Fast fashion is characterized by its ability to produce low-cost, mass-produced clothing at an incredibly fast pace to meet consumer demand for the latest trends. This model relies heavily on cotton as a primary raw material due to its affordability, comfort and versatility in textile production (Joy, 2012).

Brands such as H&M and Inditex, which owns Zara, are the world's largest clothing companies. They had combined profits of around US$41 billion in 2022. H&M has 4,400 shops around the world while Zara and other Inditex brands- Pull&Bear, Bershka, Massimo Dutti, Stradivarius- have nearly 6,000. H&M and Zara are the global leaders in the fast fashion industry, churning out numerous clothing collections each year (Earthsight, 2024).

As fast fashion brands, including H&M, Zara and others, grew in popularity, their insatiable demand for cheap cotton fueled the expansion of cotton farming in

countries like Brazil. This demand drove the increased use of Cerrado as a major source of cotton, which led to the intensification of farming practices in the region. Large-scale monoculture farming, the use of chemical pesticides, and heavy irrigation became standard in an effort to meet the industry's needs.

In the present day, Cerrado remains a critical region for cotton production, driven by the global demand for cotton from the fast fashion industry. The industry's reliance on low-cost, high-volume cotton has led to the expansion of unsustainable agricultural practices in Cerrado, contributing to environmental degradation, water scarcity, and loss of biodiversity. The region is now recognized for its role in feeding the fast fashion supply chain, where cotton is harvested and shipped globally to textile manufacturers. The environmental cost of these practices is high, with significant deforestation and soil depletion linked to the expansion of cotton farming (Muthu, 2014).

2.3 Greenwashing by Major Fashion Labels

The fashion industry has always been under increasing pressure to adopt more sustainable practices, with the volume of clothes produced, purchased and discarded, threatening the environment.

An investigation conducted by the UK NGO *Earthsight,* between January 2023 and March 2024, expressed that the cotton produced in Brazil could be linked to illegal deforestation on the Cerrado biome (Nemitz, 2024).

In investigating the" *Fashion Crime: The European Retail Giants linked to Dirty Brazilian Cotton"* report, *Earthsight* spent over a year and a half analyzing satellite images, count rulings and shipment records. The team conducted interviews and investigations both in Europe and in northeastern state of Bahia, discovering that 8 Asian firms bought at least 816,000 tonnes of Brazilian tainted cotton to make nearly 250 million items of finished clothing and homeware for global stores like H&M, Zara and related brands. (Nemitz, 2024)

The report, globally released on 11th April 2024, notes that this demand, pressures deforestation in Cerrado, which has risen by 43% in the last year and that the two main farm companies involved, SLC Agrícola and Horita Group, have a long history of illegal deforestation (Nemitz, 2024). SLC, with 440km^2 of cotton plantations in western Bahia, has been fined over US$250,000 by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) since 2008 for

environmental infractions. Similarly, the Horita Group, with 1,400km^2 of cotton plantations in the region, has been fined over 20 times by IBAMA, totaling US$4.5 million between 2002 and 2019 (MexicoBusinessNews, 2024).

According to *Earthsight*, Horita and SLC provided between 4% and 29% of the cotton for the Indonesian manufacturer Kahatex, which supplied 29% of its production to H&M between October 2020 and September 2021. Additionally, the two Brazilian producers supplied between 4% and 14% of the cotton imported in 2023 by Jamuna, a Bangladesh-based company that exports almost two-thirds of its production to Inditex, owner of Zara. The company sold US$251 million worth of clothing in Europe manufactured by Jamuna between January and August 2023, according to the report (MexicoBusinessNews, 2024).The report also deplores the lack of supply chain traceability provided by Better Cotton (BC), a certification system that aims to ensure the sustainability in cotton farming, widely used by H&M and Zara. Yet investigators found that the cotton linked to illicit activities in the Cerrado carried BC Label. This is not the first time such brands have been involved in the controversial situations. In 2023, an investigation by Swedish portal *Aftonbladet* revealed that some garments collected by H&M within its recycling program ended up in clothing landfills in Africa. This revelation raises significant questions about the authenticity of sustainable fashion practices promoted by these brands. Despite claiming the ethical sources and recycling, the lack of accountability within these supply chains often undermines these initiatives. Furthermore, the environmental and social consequences of such activities highlight the urgent need for strict regulations and greater transparency in the global fashion industry. Addressing these issues is essential to ensure that sustainability is not just a marketing strategy but a genuine commitment to a responsible practice.

3. METHODOLOGY

The research methodology for this paper includes the analysis of secondary data that will aid in the exploration of the negative side of the fast fashion industry. Through the secondary data analysis, which, in simpler terms, is the analyzing of data and research of other scholars and researchers, will provide evidence behind the impact of fast fashion on the environment of Cerrado. Using the data-driven approach that includes the ecological impact, socioeconomic and policy implications, it helps to

deliver the conclusion on the ecological degradation of the Cerrado biome by these industries, which is consistently neglected due to the lack of knowledge. An analysis of this paper's findings will illuminate how the fashion brands are using illegal and unsustainable ways to produce profits which have caused harm to the environment, especially in Cerrado region.

To come to this conclusion, an overview of fast fashion industry in Cerrado is being discussed first and based on this information, with the help of findings from secondary data research; an informed decision about the impact of fast fashion industry on Cerrado's ecological biome is being discussed.

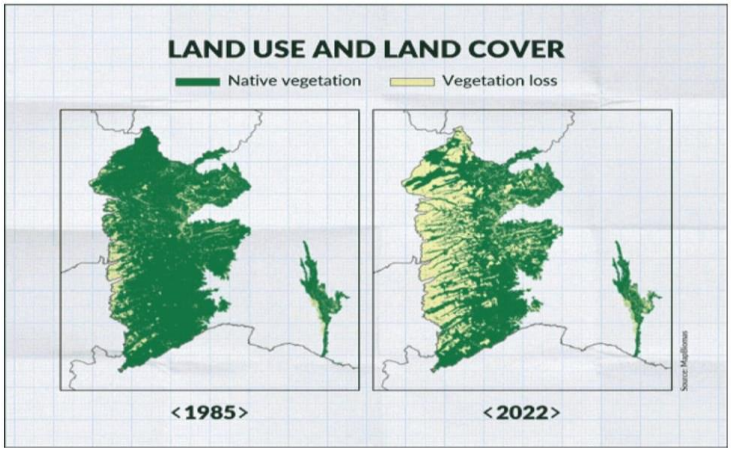
4. DISCUSSION

With over 4,800 plant and vertebrate species, Cerrado is a global biodiversity hotspot, spanning three of the largest watersheds in South America, contributing 43% of Brazil's surface water outside the Amazon. Despite its enormous importance for species conservation and provision of ecosystem services, the Cerrado has lost 88Mha (46%) of its native vegetation cover. Between 2002 -11, deforestation rates in Cerrado were 2.5 times higher than in the Amazon. As of present, the biome has lost 11,011.7 km^2 of native vegetation between August 2022 and July 2023, according to the data from PRODES Cerrado. This loss of biome is mainly due to agricultural practices which are mostly involved in cotton production, due to the demand of fashion industry. This data was released at an event held in Brasilia by the Ministry of Environment and Climate Change (MCC), at which the Action Plan for the Prevention and Control of Deforestation in the Cerrado (PPCerrado) was also released.

Contrary, to what happened in the Amazon, throughout 2023, deforestation in Cerrado remained at high level. The states that deforested the most were Maranhão (2,929 km^2), Tocantins (2,234 km^2), Bahia (1,972 km^2) and Piauí (1,128 km^2). They all belong to Matopiba, the country's most recent agricultural frontier, indicating the advancement of commodity production and environmental destruction. The state of Bahia had a 38% increase in deforestation in 2023 as compared to previous years. These increased rates of deforestation have led to a change in the "Land use -Land cover" (LULC) of the Cerrado biome. According to the Brazilian Institute of Geography and Statistics, "Land use" is the human activities that make use of the land resources associated with the socioeconomic function of the

surface, and “Land cover” is the elements of nature (e.g., natural and planted vegetation, water and soil).

Methodologically, the survey of land use and land cover indicates the geographical distribution of the type of land use (IBGE, 2013). According to the MapBiomas Project collection 7.1, between 1985 and 2021, Cerrado presented a reduction in the savanna formation of 24.9%, in forest of 15.3% and in non-forest natural formation of 13.9%. In the Mato Grosso do Sul, the scenario is similar considering the same period (1985-2021) with a decrease in forest cover (from 53,641.36 km^2 to 36,689.70 km^2) and an increase in agriculture (from 156,110.60 km^2 to 212,380.26km^2) (MapBiomas, 2024).



(Land use and land cover dynamics of Cerrado
Credit: Mongabay /MapBiomas /Earthsight 2023)

Not only this, the loss of vegetation cover has also reduced the region’s ability to act as a carbon sink, accelerating climate change. It is estimated that agricultural production and land conversion are consuming the critical reserve of one-sixth of all Brazil’s stored carbon and releasing 304 million tones of CO_2 in 2022, nearly one-fifth of Brazil’s total net emissions (Forum, 2024). Forest carbon emissions from cropland expansion increased over the past decade in Matopiba, that includes portions of Maranhão, Tocantins, Bahia and Piauí. Gross carbon emissions from croplands expansion in Cerrado averaged 16.28 Tg C yr^{-1}, between 2003 and 2013, with forest-to-cropland conversion accounting about 29% of missions. The fraction of forest carbon emissions from Matopiba was much higher; between 2010-13, large scale cropland conversion in Matopiba contributed 45% of total Cerrado forest carbon emissions (Noojipady, 2017).This release of stored carbon from forest ecosystems has

amplified the Cerrado's contribution to the greenhouse gas emissions, significantly increasing its carbon footprints.

To meet the growing demand for cheap cotton by fashion industries, vast areas of this biodiverse savanna were also cleared for monoculture plantations, which involves growing single crop on an industrial scale. This has resulted in the destruction of habitat critical for countless species, many of which are endemic to Cerrado. Nearly, a fifth of the species, including the Maned wolf, Pampas Cat, Giant Anteater and blue-eyed Ground Dove, have faced extinction due to habitat loss. (WWF, 2007) High plateaus, once thriving with blue macaws (*Anodorhynchus hyainthinus*) and jaguars *(Panthera onca*), have now been transformed into expansive soy and cotton monocultures. Additionally, the fragmentation of ecosystem has disrupted the wildlife migration patterns and ecological balance of Cerrado (Earthsight, 2024).This widespread habitat destruction not only threatens biodiversity but also undermines the ecological services that Cerrado provides, such as water regulation and soil fertility. Local residents suffer issues of water scarcity. Dry riverbeds and lost springs have become common in Cerrado. This is because, cotton is a water intensive crop and although Cerrado has a well- developed drainage system, but due to the unsustainable and illegal cotton growing practices, it is facing water scarcity issues nowadays. It is estimated that the production of a single cotton t-shirt requires around 2,700 litres of water, which is equivalent to sustaining a human being for two and a half years (Galloway, 2024). Agribusinesses in western Bahia extract nearly 2 billion litres of water per day but they pay this back by dumping 600 million litres of pesticides in Cerrado each year. According to the United Nations Environment Programme (UNEP), cotton cultivation occupies 2.5% of the world's arable land but consumes 200,000 tons of pesticides and 8 million tons of fertilizers annually, accounting for 16% and 4% of global use respectively. Recent studies on potential pesticide contamination were carried out by the Health Ministry's System for Monitoring the Quality of Water for Human Consumption with data from 2014. Their studies revealed that the concentration of pesticides in water were above the margin of safety, following the criteria from European Union. The water quality studies showed that nitrogen enrichment in agricultural catchments, indicating fertilizer impacts and potential susceptibility to eutrophication. These pesticides were consistently detected throughout the entire aquatic system. In several case studies, extreme concentrations

of pesticides exceeded Brazilian and European Union (EU) water quality limits, leading to potential health implications. The pesticide industry has experienced a steady growth based on both agricultural supply and demand (Hunke, 2014). Additionally, the degraded water quality due to nitrogen enrichment and pesticide runoff, have significantly affected the local communities and the expansion of these agricultural practices has changed the local economies of Cerrado. While these industries contributed to their profits, they often do so at the expense of traditional livelihood, leading the displacement and loss of income for indigenous population.

In the municipality of Formosa do Rio Preto, Horita grows cotton on a third of a mega estate called Estrondo. The Horita Group, being the largest landholder at this estate, has been closely linked with the violent land disputes against traditional communities, which have inhabited the area since 19th century. Such communities, known as *Geraizeiros*, have also lived in harmony with nature for generations and are protected by law, having the right to their traditional lands guaranteed.

However, in 2018, it was found out that Estrondo was one of the largest areas of land grabbed in whole of Cerrado. These lands were public lands, which belong to Bahia and were reserved for *Geraizeiros* communities. In 1970s and 80s, findings showed that, Estrondo's owner has illegally appropriated over 400,000ha of public land which was covered in native vegetation. Over the decade, half of this area was deforested and many *Geraizeiros* communities had experienced intimidation, harassment and even shot by armed men working for this Group. They were being confined to small areas with their traditional, low-impact activities. (Benson, 2024)

Another case of land grabbing, has afflicted the traditional communities of Capão do Modesto in the Correntina Municipality. The large agribusinesses have been accused of misappropriating public lands to convert them into "legal reserves". But instead of setting aside the parts of their productive properties as legal reserve, they have acquired land elsewhere for this purpose. The Horita Group has a 2,169-ha property at Capão do Modesto and SLC's Paysandu farm, which grows cotton, is linked to a legal reserve at Capão do Modesto. Bahia's attorney general has referred to Capão do Modesto as "one of the most serious land grabbing cases in Bahia," and requested the suspension and eventual cancellation of all land titles overlapping it (Earthsight, 2024). Although, efforts have been made to curb the rampant land grabbing cases, but these initiatives have fallen short as the environmental destruction is already at its peak and lack of enforcement mechanisms and influence of powerful agribusiness

lobbies connected to fashion industry, have already caused severe ecological and socioeconomic destruction.

Walter Horita, one of the Horita Group owners, was the subject of federal investigation in 2019, in which he was alleged to have paid millions of dollars in bribes to court officials. In 2003, three Ibama agents were accused of issuing Estrondo with fraudulent permits to clear land. Court documents show they were subsequently suspended and sued for corruption but most of the land they issued permits for, has been cleared regardless (Benson, 2024). The National cotton producer's association (ABRAPA) is in charge of the ethnical certification programme, which is facing a serious conflict of interest. Similar issues exist in auditing processes where auditors are paid by and depend on the certified companies for their business. H&M and Zara, currently lack the policies and tools to make up for Better Cotton shortcomings. Their human right and sustainability policies have failed to address communities' right or deforestation. Inditex's ecological commitments do not seem to extend to its cotton suppliers, leaving their sustainability efforts fundamentally incomplete.

5. CONCLUSION

To come to a conclusion, about the impact of fast fashion supply chain in Cerrado, considering the analysis from environmental context is not very conducive. The environmental standpoint conveyed only negative outcome for society in the long term. The ecological degradation of Cerrado due to deforestation, monocultural practices, pesticides and fertilizers, highlight the devastating consequences of industrial agriculture, not only on water bodies, soil and wildlife species but also on human health and economy. Cotton production, fueled by global demand for cheap and rapid textile manufacturing has resulted in irreversible ecological conditions. Rampant deforestation, biodiversity loss and water scarcity have pushed this critical biome closer to ecological collapse. Addressing the 26th Session of the Committee on Forestry (COFO), FAO Director-General Qu Dongyu stated that "deforestation and land degradation, together with biodiversity loss, are devastating our ecosystems." He underscored the critical importance of halting deforestation, affirming that it is "key to tackling the climate crisis by both cutting greenhouse gas emissions by 14% and safeguarding more than half the Earth's terrestrial biodiversity."

The social outlook findings suggested, the issues of land grabbing by these large agribusinesses, resulting in the displacement and loss of income by the traditional

population. The ineffectiveness of sustainability certification like Better Cotton, coupled with the negligence off major fashion brands such as H&M, Zara and Inditex, underscores a failure to align profit motives with genuine environmental stewardship. Moreover, the absence of comprehensive and transparent government planning had fostered an environment ripe for corruption. This had resulted is irrevocable environment changes in the Cerrado biome. Until substantial shifts are made in consumer behavior, corporate responsibility and global policy, the future of Cerrado and its ecosystem remains bleak.

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