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"IMPORTED" DEFORESTATION: BRAZILIANS AND THE ENVIRONMENT FACE THE REPERCUSSIONS OF SOYBEAN TRADE

DEFORESTACIÓN "IMPORTADA": LOS BRASILEÑOS Y EL MEDIO AMBIENTE SE ENFRENTAN A LAS REPERCUSIONES DEL COMERCIO DE LA SOJA

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ABSTRACT

This paper aims to analyze the environmental and social destruction caused by soybean production in Brazil. The semi-structured interviews conducted with experts in the field and existing data clearly show the effects of bad governance and lack of local policies. There are numerous countries involved in the exportation/importation of soybean who contribute to the deforestation of not just the Amazon Rainforest but other biomes critical to indigenous communities and biodiversity of the world. As the demand for agricultural land increases we must find sustainable alternatives for producing soybean and minimizing its impact.

Keywords: Brazil, soybeans, deforestation, exportation, sustainability

RESUME

Este trabajo pretende analizar la destrucción ambiental y social causada por la producción de soja en Brasil. Las entrevistas semiestructuradas realizadas a expertos en la materia y los datos existentes muestran claramente los efectos de la mala gobernanza y la falta de políticas locales. Hay muchos países implicados en la exportación/importación de soja que contribuyen a la deforestación no sólo de la selva amazónica sino de otros biomas críticos para las comunidades indígenas y la biodiversidad del mundo. A medida que aumenta la demanda de tierras agrícolas, debemos encontrar alternativas sostenibles para producir soja y minimizar su impacto.

Palabras clave: Brasil, soja, deforestación, exportación, sostenibilidad

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ABBREVIATIONS AND ACRONYMS

ABIOVE: Brazilian Association of Vegetable Oil Industries

ANEC: Association of Cereal Exporters in Brazil

CONAB: National Company of Food and Supply

EMBRAPA: Brazilian Agricultural Research Corporation

FAO: The Food and Agriculture Organization

GM: Genetically Modified

GMO: Genetically Modified Organisms

IBGE: Brazilian Institute of Geography and Statistics

MST: Movimento dos Trabalhadores Rurais Sem Terra (The Landless Workers' Movement)

SDGs: Sustainable Development Goals

SFS: Sustainable Food Systems Programme

SoyM: Soy Moratorium

CHAPTER 1: INTRODUCTION

1.A. MOTIVATION

The purpose of this research paper is to be an advocate for the voiceless, listening to the people, animals, and environment that cannot go on being ignored. The motivation for researching soybean production in Brazil started on a personal level. I live on a plant-based[1] diet to stay healthy, reduce my carbon footprint, and for the respect I have for animals. In my opinion, for vegans, the consumption of soy products, mainly tofu,[2] is necessary for a well-balanced diet allowing the right nutritional amount of protein. My research was prompted by a question about my feelings towards contributing to deforestation by eating soy.

In the last decades, soybean farming and production has had a positive impact in terms of economic opportunities for soy-producing countries. According to the UN's Food and Agriculture Organization (FAO), 80% of the world's entire soy production come from three countries: Brazil, the United States, and Argentina. In particular, Brazil has benefited from increased productivity growth which has opened up the country for investment in agricultural innovation, trade liberalization, and more jobs. Consequently, it has also brought devastation.

Most have seen the photos of the Amazon burning or watched videos of land being routinely cleared for farming, at rates so high that Harvard estimates between 3.5 to 7 billion trees are cleared each year. There are millions of hectares of Brazilian rainforest being legally or illegally destroyed due to soybean production, and there is a tight economic grip on the exportation of soybean in Brazil. Year after year, the demand for soybean increases, and Brazil attempts to supply that demand at the expense of its natural resources. Deforestation, loss of biodiversity, endangered wildlife, water and soil contamination, human rights violations and livelihood vulnerability are some of the negative results when short-term profits are prioritized over long-term sustainability.

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[1] **Plant-based** foods are primarily from plants. This includes not only fruits and vegetables, but also nuts, seeds, oils, whole grains, legumes, and beans.
[2] **Tofu** a popular plant-based food made of condensed soymilk that is pressed into solid blocks and used as a meat substitution.

Moreover, there is a clear misunderstanding on the principal use of soy and the contributing factors that have led to this immense destruction. Soybean is grown in Brazil for animal consumption. Ninety-six percent of the soy farmed from the Amazon is used in animal feed, fed mostly to cows, pigs, and chickens, and more recently to farmed fish.

If none of this raises a red flag, consider our planet without its "lungs," as the Brazilian Amazon is notoriously referred to. This comparison is given due to the crucial role it plays in regulating carbon dioxide levels while producing 20% of the oxygen in our atmosphere. Without the Amazon, future generations will experience higher temperatures, poorer air quality, and overall environmental challenges that will not be limited to just Brazil, but that will impact the entire world.

1.B. RESEARCH PROBLEM AND RESEARCH QUESTIONS

Research Problem

As stated in my motivation, the destruction of Brazilian land continues to be a major issue for climate change and human rights, as this clearly affects many, and little has been done to change the outcome. There are numerous countries involved in the production and exportation/importation of soybean. As the demand from Asia and Europe increases, it is difficult to see how the Brazilian government will achieve the UN Sustainable Development Goals of 2030. In the research found on soybeans, every hectare stolen from the Amazon, the loss of biodiversity in the Cerrado Biome,[3] and the land stolen from the farmers is well documented. The problem lies in the large gap of research on finding sustainable alternatives for producing soybean and minimizing its impact. Brazil is not the only country affected socially, economically, and politically—this destruction is spreading to the entire South American continent. A prime example is another forest in Argentina, the Gran Chaco,[4] that in the last 20 years has experienced a 25% deforestation rate for agriculture farming, mainly extensive crops (soybeans) and livestock production.

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[3] **Cerrado Biome** is a large ecological tropical biome composed of savannas and grasslands, covering about 21% of Brazilian territory.

[4] **Gran Chaco biome** extends over Argentina, Paraguay, Bolivia, and a small part of Brazil, bringing together more than 50 different ecosystems united by the same pattern of vegetation and climate. It also provides an environmental and bioclimatic balance for the continent. Source: The Nature Conservancy.

We need forests, trees, and vegetation to breathe. The forests around the world provide us with clean oxygen while removing the carbon from atmosphere. There is a lot of money being made in Brazil, and major international companies are profiting from this trade. This is a great opportunity for research in this field to show the limitations of trade and to use relevant information to reflect on the future and climate change.

Research Questions

This research seeks to answer the following questions:

1. Who is suffering the repercussions of soybean production and trade and what role does the Brazilian government play?
2. Does the increase in Brazilian soybean production pose a threat to the rainforests and savannas of Brazil?
3. What sustainable alternatives are there for the production of soybean that can be used to prevent environmental destruction?

1.C. METHODOLOGY

In order to gain better insight on soybean production and trade in Brazil, the methodology used for this research paper focused on qualitative research methods: semi-structured interviews and analysis of existing data.

Semi-structured Interviews

The interviews were conducted through an online video conferencing platform, lasting between 45–60 minutes. The same questions were asked to four out of five interviewees. The questions were geared towards their prior research on soybean production, increased demand for soy, their knowledge of soybean production in Brazil, human rights infringements, environmental destruction, and sustainability. Each topic was examined to gain an understanding of the interviewees' perceptions and motivations. The fifth interview was completed through emailed questions focused solely on the interviewee's expertise with Biotech companies and sustainable alternatives in Brazil.

All interviewed participants signed an authorization for audio/video recording and commitment to confidentiality by the researcher of the University of the Institute of Migrations or provided written consent and authorization. Answers were recorded and notes were taken during the interviews. This interaction allowed for a more flexible and transparent way of communicating real-life and first-hand experiences and information.

The recorded interviews were transcribed, and a thematic analysis was conducted. One interview, which was conducted mostly in Portuguese, was translated to English after the transcription. The final topic relates to the possibilities of sustainable soybean production in Brazil and, interestingly enough, each of the interviewees had similar alternatives and shared ideas.

The information and data extracted for this research were obtained from the answers provided by the interviewees and their experiences in their respective fields. Each interviewee was selected based on their expertise. It was inspiring to listen to women and men who have dedicated their careers to science and the environment.

Initially the research method included interviews with Brazilian farmers and producers. However, it was challenging to interview them while not being in-country and given their limited access to the virtual platform. Three out of the five interviewees had firsthand experiences and were able to provide information on the challenges and struggles farmers and producers face, both directly and indirectly related to soybean production.

Existing Data

Tables, charts, and graphs were utilized to support the literature review of this research paper. Google Scholar research, articles, and books were used along with recommendations from the interviewees. Most of the data was concentrated on the last 10 years. It was summarized and collated to increase the overall effectiveness of the research problem.

1.D. OBJECTIVES AND HYPOTHESIS

The general objective of the research is as follows:

Research soybean production in Brazil and how this unsustainable production system contributes to deforestation and socio-economic problems for Brazilians.

The specific objectives of the research are as follows:

1. Analyze the increased demand of soybean and soybean byproducts in the last decade.
2. Investigate the devastating effects soybean production has on the environment such as deforestation, loss of biodiversity, and contamination.
3. Identify the challenges organizations, cooperatives, NGOs, etc. face when working with soybean production companies in Brazil.
4. Validate the importance of a sustainable soybean production system.

As a result of the stated objectives, the research is based on the following hypotheses:
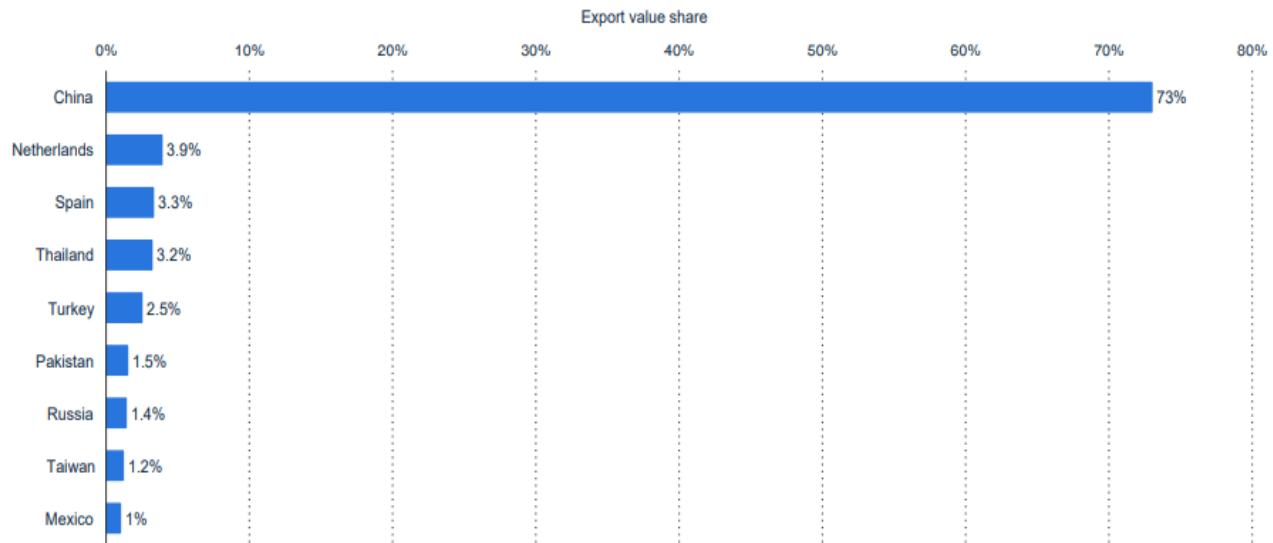
The increased demand for soybean primarily for animal feed, food, and biofuels will continue to exploit farmers and workers while destroying Brazil's land and rainforest. The profitability of this free market demand will continue to impede any sustainable, balanced, and fair agricultural trade. Without a concerted effort from the Brazilian government and international players, an intervention to combat and prevent further damage will be difficult.

CHAPTER 2: LITERATURE REVIEW

## 2.A. BACKGROUND OF SOYBEAN PRODUCTION AND TRADE IN BRAZIL

It is important to understand the past and present situations of soybean production and trade in Brazil in order to see where the future of soybean is headed. Therefore, this chapter focuses on how the soybean arrived in Brazil and where it stands today.

The soybean originates from China where wild and domesticated cultivation can be found in historical records dating back thousands of years. China was once the world's largest producer and exporter of soybean until demand exceeded in-country supply. Today China is the largest soybean importer and Brazil is China's primary supplier as shown in Figure 1.

Export value share

Country	Export value share
China	73%
Netherlands	3.9%
Spain	3.3%
Thailand	3.2%
Turkey	2.5%
Pakistan	1.5%
Russia	1.4%
Taiwan	1.2%
Mexico	1%

Figure 1. Leading countries of destination for soybean exports from Brazil in 2020, by export value share. Adapted from Statista.

In the 1950s, the United States started producing soybeans, and at present is the largest producer of soybean in the world. Brazil, seeing the market potential, started producing soybean in the 1970s. Although it has a tropical climate, very different from the USA and China, the cultivation of soybeans was successful. Fast forward to 2018, Brazil's soy exports surpassed the United States for the first time (Cattelan and Dall'Agnol, 2018). Presently, Brazil and the USA continue in the race alongside Argentina, who is not far behind when comparing the size and export ratio of the country as shown in Figure 2.

Top 10 Country, Export Quantity of Soybeans
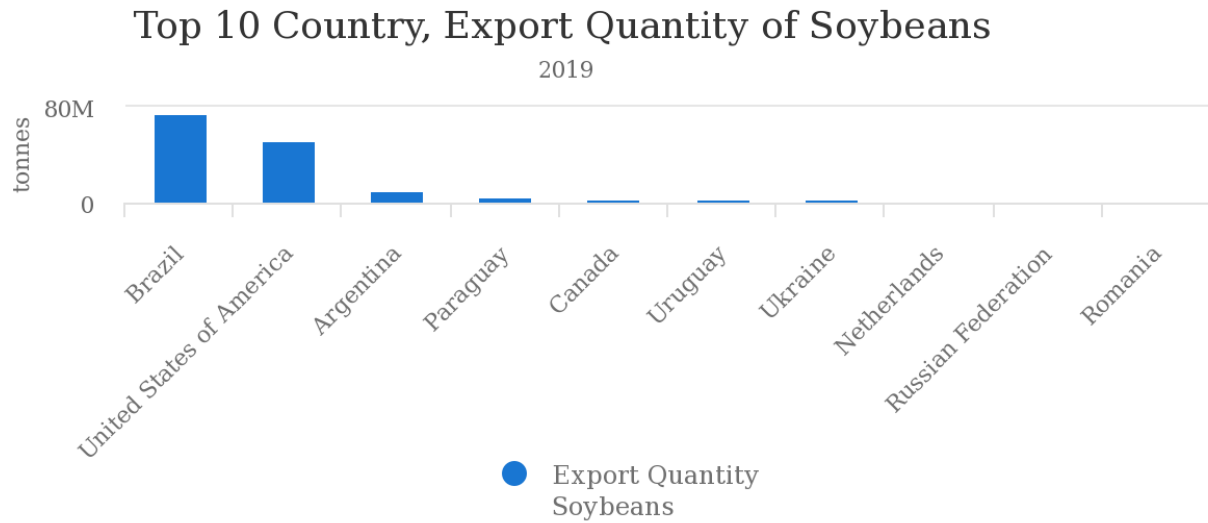
2019

Source: FAOSTAT (Jun 10, 2021)

Figure 2. In 2019, Brazil continues to surpass the United States in export quantity of soybeans. This chart also shows the top 3 countries exporting soybeans (Brazil 74,073,074 tonnes, USA 52,388,397 tonnes and Argentina 10,053,802 tonnes). Adapted from www.fao.org.

Once soybean arrived in Brazil it quickly expanded from the southern region to the mid-west. In the 1990s, it expanded towards the central north, and in the 2000s it expanded even farther north. The importance of soybean for Brazilian agricultural development has been significant, opening the country's farming capacity to produce other crops such as maize. Together, soybean and maize account for more than 80% of the total farming area and 85% of the production of grains in the country (Cattelan and Dall'Agnol, 2018). Other main crops grown in Brazil are wheat, rice, common beans, coffee, cotton, and sugar cane. Today, Brazil's soybean cropland is an estimated sum of all these areas combined. "The king of all beans," which is often a reference to the soybean, has a huge social, economic, and environmental impact, as it continues to take over massive amounts of valuable, arable land. The expansion of soybean cultivation into the Amazon has generated discussion and controversy among researchers, NGO activists, and politicians. This debate often lacks a deep and consistent grasp of the meaning of this rapid expansion in Brazil. The behavior of the world market is fundamental to understanding the growth of internal and external demands for this commodity in a globalized market (Cattelan and Dall'Agnol, 2018). Analysis shows that there is a higher growth in Brazilian soybean exports in relation to the growth of domestic consumption, compared to the USA where it has remained stagnant throughout the years. In China and the European Union, the domestic consumption has indeed increased.

CHAPTER 3: THEORETICAL FRAMEWORK

3.A. INCREASED SOYBEAN DEMAND

There are several factors that come together to intensify competition and the demand for agricultural resources and food products between countries. Globalization and increased wealth in developed countries has put domestic pressure on food production, resulting in outsourcing to underdeveloped countries such as Brazil. An example of this is the arable land requirement for Brazil to feed its population: It has not shown a significant increase, yet the expansion and intensification of agricultural lands during the past two decades have led Brazil to be one of the world's major food exporters (Bicudo da Silva et al., 2020b).

Soybean Exports: Brazil

Figure 3. The chart shows Brazil's soybean exports in metric tons and the major increase from 2006 to 2020. Adapted from: Statista, 2021.

The global demand for agricultural commodities is driven by four factors (the four F's); food, feed, fuel, and finance (Turzi, 2017). The second factor, feed, is crucial in understanding the situation occurring in Brazil. A demand for feed is linked to the rise of the emerging world with a regional focus on Asia. As China continues to grow and lift their people out of poverty—an estimated 800 million since 1978[5]—living standards have begun to rise, leading to an increased demand for meat and dairy products. This not only means more people to feed but also more animals to feed. With the high demand for meat coming from across the world, Brazil's soybean production increased immensely to meet this demand, as shown in Figure 3.

In the last 10 years soybean production has contributed to the deforestation of the Amazonian rainforest, clearing out hectares of land that is home to wildlife and indigenous communities in order to make room for more large-scale soybean plantations. Small agricultural farmers and workers have also been affected, as they too are at the bottom of this "food chain," with no authority on how their plantations should be run. Another key point to touch upon is the construction of a new soybean geography. The Amazon and Cerrado Biome are closed ecosystems; as a result, the country has generated new transportation logistics and constructed establishments of multinational grain commercialization and industrialization units, which have altered the geographical design of Brazilian agriculture (Bustos et al., 2016). New routes and transportation strategies have and continue to shape the infrastructure of Brazil. This infrastructure's main goal is to connect systems of railways, highways, waterways, and ports to major exportation facilities, crossing through even more parts of the Amazonian rainforest and Cerrado Savanna. This geographical change confirms, yet again, the relationship between soybean expansion and its presence in the equatorial forest ecosystem of the Legal Amazon[6] (Frey et al., 2018).

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[5] The World Bank estimates an almost 10% a year GDP growth since China began to reform its economy in 1978, and more than 800 million people have been lifted out of poverty to date. China is now an upper-middle-income country.
[6] The **Legal Amazon** corresponds to the area under the responsibility of the Superintendence of the Amazon Development – SUDAM established by Article 2 of Complementary Law no. 124, of 03/01/2007. The region is formed by the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins and Mato Grosso, and the municipalities of the state of Maranhão.

3.A.1. SOYBEAN-BASED ANIMAL FEED

International trade has chosen soybean to be "the king of all beans" because a single soybean is about 40% protein and about 20% oil content, making this crop the highest in protein and highest gross output of vegetable oil in the world (Singh, 2010). It is a highly efficient crop: the total cost of the crop is relatively low compared to its unit protein value. About 35-38% of the calories in soybeans are derived from protein, compared to 20-30% found in most other beans. The soybean is considered a money-making bean. Yet, the FAO does not consider the soybean a bean or legume. Although it is taxonomically correct to associate soybeans within the vegetable family, the FAO does not include soybeans among vegetables, nor does it use this denomination for seeds intended for biofuel production (FAO, 2016, p. 13). In China, the soybean was considered a sacred grain and essential to the stability of Chinese civilization (Pinto et al., 2007). For hundreds of years soybean has been one the of the main sources of protein and vegetable oil. It can be used for human consumption, making it the second largest source of vegetable oil in the world. When processed for human consumption it can be found in a variety of forms: soy meal, soy flour, soy milk, soy sauce, tofu, lecithin and oil (Turzi, 2017). Another form of soybean in its crude state is extracted for biodiesel.

Soybeans are one of the few complete protein vegetable-based foods that have all nine essential amino acids. For this reason, 85% of its cultivation is destined for animal feed. The protein in soybean is used to quickly fatten up cows, pigs, chickens, and farmed fish so that they can be slaughtered and sold on the meat market at higher prices. Global meat consumption has also increased over the past 50 years. Meat production today is about five times higher than in the early 1960s, rising from 70 million tonnes to 330 million tonnes in 2017 (FAO, 2019). The USA, Europe, and China consume most of the world's produced meat. According to the FAO's Meat Market Report, despite a challenging global meat market environment in 2020, the world's largest meat exporters (the European Union, the United States, Brazil, Canada, the Russian Federation and Mexico) all shipped out more meat than in 2019. As the research shows, increased global income leads to an increase in consumption of meat, which drives higher demand for the production of animal feed, of which the number one ingredient is soybean. This proves a strong connection between the demand for meat and soybean production for animal feed. Following this

trend, an increased demand for soybeans will continue, only further straining the environment. Nature and humans alone cannot produce what is being demanded.

3.A.2 GENETICALLY MODIFIED CROP

Genetically modified (GM) crops were officially authorized in Brazil in 2003. A GM soybean seed is modified in a laboratory to either resist weeds/unwanted plants, insects/disease, or both allowing for less use of pesticides[7] in the farming process. A study done in Brazil suggested something different, however. GM crops instead contributed to an increase in herbicide use from 2000–2012, consequently heightening human and environmental exposure to potentially hazardous chemical substances (Soares de Almeida et al., 2017). This increase indicated a possible chemical dependency of these soybean croplands. Another relevant aspect of this study was that this increase in pesticide use did not result in an increase in productivity. The two most widely used herbicides in Brazil are glyphosate and 2,4-D. They have been classified as probable and possible carcinogens by the International Agency for Research on Cancer (IARC). A Brazilian bean farmer in the documentary *Soyalism* expressed his concern for the different ways soybean farms fight pests. He stated that they use large amounts of pesticides, which he believes do not kill them but simply relocate the pests to his small farm, infesting his crops instead. As of a result of this, he has stopped growing beans and struggles to make ends meet. In the interview with a Brazilian socio-environmental researcher at Michigan State University, it was surprising to learn that almost 95% of soybean produced in Brazil is GMO,[8] as most of this soy is intended for the factory farm animals in Europe and China, not for direct human consumption. Most countries have strict regulations in place for allowing GM crops to be imported for human consumption. There is a niche market for non-GMO soybeans, and Brazil is also one of the countries that continues to produce them. It is the largest remaining producer of non-GMO soybeans in the world, producing approximately 15 million tonnes each year. The next largest producers of non-GMO soybeans are China (14 million tonnes), India (12 million tonnes) and the United States (6 million tonnes). India and China

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[7] **Pesticides** are chemicals that may be used to kill fungus, bacteria, insects, plant diseases, snails, slugs, or weeds.
Insecticides are a type of pesticide that is used to specifically target and kill insects.
Herbicides are used to kill undesirable plants or "weeds." (Source: Pesticide Action Network).

[8] **Genetically Modified Organism** is an organism or microorganism whose genetic material has been altered by means of genetic engineering.

produce a large volume of non-GMO soybeans, but unlike Brazil, they do not export most of their production due to their high domestic consumption (Garrett et al., 2013).

3.B. EFFECTS OF SOYBEAN PRODUCTION ON THE ENVIRONMENT

There is a strong correlation between soybean production and deforestation in Brazil. The effects on the environment are causing serious problems for Brazil and contributing to global climate change. Deforestation is not the only concern; hectares of other parts of Brazil like the Cerrado Biome are being cleared out as well. The fertilizers and pesticides used in the farming processes are contaminating the air, soil, and waterways, causing health problems for Brazilians and indigenous communities.

Deforestation

Brazil's Amazon Rainforest is the world's largest rainforest. Since the 1970s, deforestation and environmental degradation has significantly increased resulting in the loss of 14% of the forest area. Production-oriented agriculture remains one of the main causes of deforestation (FAO, 2020). The United Nations estimates that between the years 2000 and 2010, large-scale commercial agriculture was responsible for almost 40% of deforestation, notably through livestock breeding, soybean cultivation, and palm oil production in Brazil. The pace of rainforest destruction has not slowed down as shown in Figure 4.
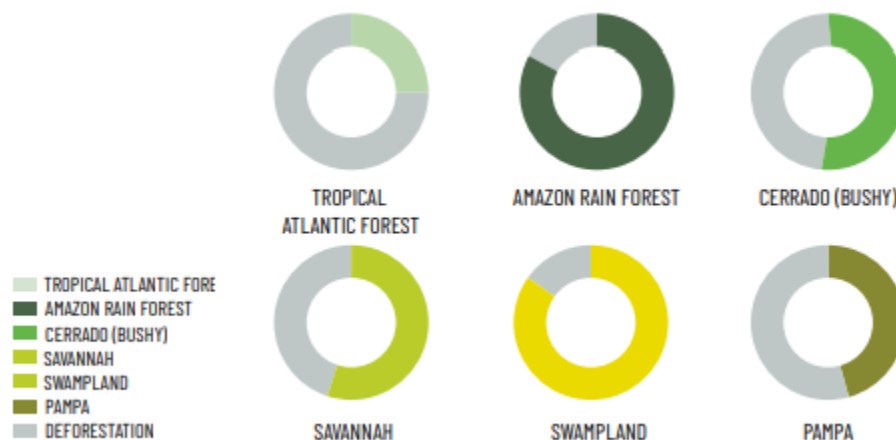
Figure 4. Deforestation by biome in Brazil shown in gray. Adapted from Mapa Bioma.

Rainforest Rescue estimates that around 10.4 million hectares, an area the size of Portugal, are still disappearing each year. "Imported deforestation" is a term first used by the president of France, Emmanuel Macron, to express the global issue and the contributors of deforestation. He argues that importing a commodity like soybean aids deforestation, making France just as accountable. The importing country becomes a part of the problem and not the solution, as if they were directly setting fire to the forest. Deforestation has also led to the release of 210 million tonnes of carbon dioxide equivalent emissions, impacting air pollution in Brazil. Deforestation hit a record high between June 2019 and June 2020, increasing by 35% in the Amazon and 30% in the tropical Atlantic Forest,[9] which had already lost 75% of its area throughout history (Nilo and Fernandes, 2020).

Loss of Biodiversity

The Amazon tropical rainforest and Cerrado Biome are rich ecosystems with incredible biodiversity, full of plant and animal species that cannot be found anywhere else in the world. The timber trade continues to benefit from the land cleared for agricultural purposes, meanwhile many native plants and animals are losing their homes. Soybean cultivation is associated with the ongoing loss of biodiversity of the Amazon and the Cerrado. Despite the 70% decrease in deforestation rates from 2005 to 2014 in the Amazon, after the signing of two "zero deforestation" agreements,[10] soybean cultivation moved to the Cerrado. The Cerrado is not as widely recognized as the Amazon, but it is equally or even more important in terms of biodiversity for Brazil and the rest of the world. The Cerrado has more than 12,000 plant species; about 4,000 only exist in Cerrado and cannot be found anywhere else. Once they disappear, they are gone forever. There are also more than 1,600 species of mammals, birds, and reptiles that have been identified in the Cerrado. These animals and plants are used to natural fires that can occur during its dry season. They have survival tactics they have adapted to over the years to protect themselves. Agricultural fires are different, started intentionally to clear out an area faster and can even spread to areas not intended for clearing. After the fires have turned everything to ash, heavy machinery is used to

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[9] The **Atlantic Forest** is another vital ecosystem filled with unique plant and animal species. It extends along the Atlantic coast of Brazil from Rio Grande do Norte state in the northeast to Rio Grande do Sul state in the south and inland as far as Paraguay and the Misiones Province of Argentina.

[10] The two agreements signed were: the **2006 Soy Moratorium** and the **2009 Brazilian Federal Prosecutors' Terms of Adjustment of Conduct**, both to prevent commodities traders from purchasing soy and cattle raised on newly deforested land.

clear out and pull rooted plants and trees, killing them and anything that gets in the way. These fires make it very difficult for the land to rebuild itself. Once the land is turned into a soybean plantation, it is no longer the home of the native animals and plants, causing major habitat losses and endangered species. Brazil attempted to work towards protecting the Amazon, however, while one region was being protected it simultaneously caused an increase in deforestation in other, less-protected areas, such as the Cerrado as shown in Figure 5. Evidence suggests that an estimated 22 million hectares of native vegetation have been deforested in the Cerrado Biome due to the expansion of beef and soybean production between 2006 and 2017 (Voora et al., 2020).
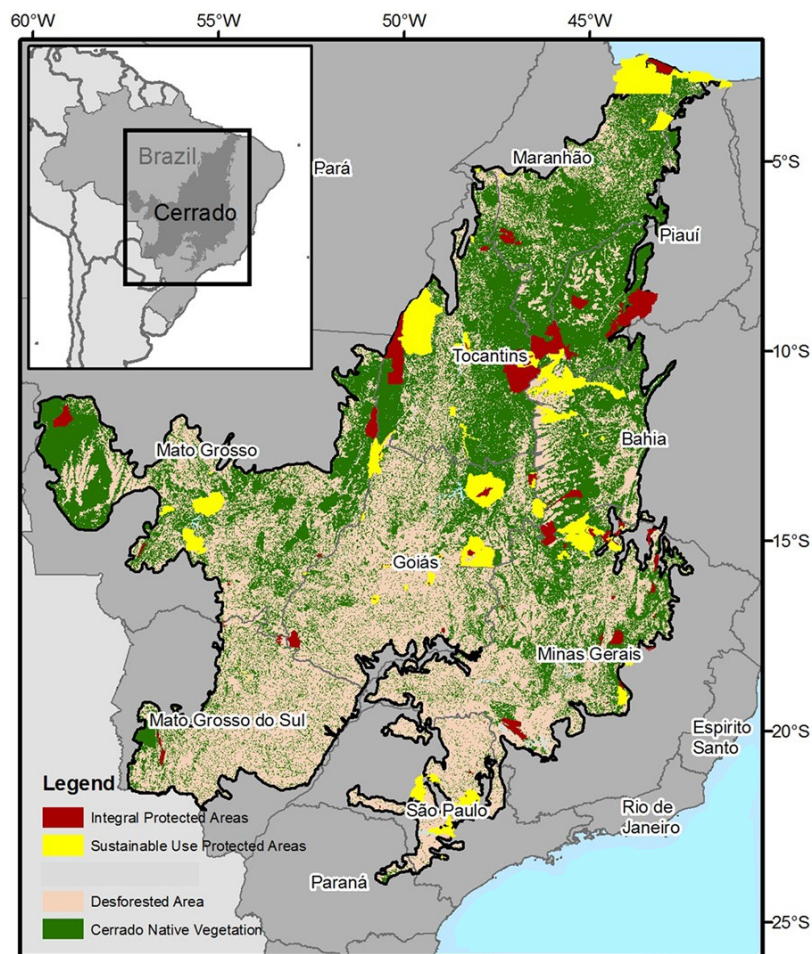
Figure 5. The map shows the location of the Cerrado biome and its ratio to the country and all its states. The few red parts are the protected areas in Brazil. It is important to see the ratio of deforested area, tan color, compared to the rest of the country. Adapted from Françoso et al., 2015.

Contamination

The research analyzed showed that as more GM seeds were being used in the farming of soybeans, more pesticides were being administered to protect the soy plant. During the interview with agro-environmental researcher and her supervisor from the University of Rio, it became clear that pesticides and herbicides can cause harm to the soil and kill off valuable nutrients needed to grow soybeans and other crops. The researcher stated that there is an obvious difference between the agricultural culture of small producers and the soy agribusiness, but whether they have a small farm or a big one, they all have the same farming issues. With government support and funding, farmers from all over Brazil come to the laboratory to have a chemical soil analysis to figure out why they may not be producing. To compare the two top soybean producers (USA and Brazil), an interview was conducted with an American technical agronomist who lives and grew up on a soybean and maize (corn) farm. She emphasized the importance of crop rotation. The most cultivated crops in Brazil are soybean and maize. As of 2011, Mato Grosso and Paraná, the two largest producing states in Brazil, produce both commodities soybeans and maize, but there are still many farms that do not. When farmers do not rotate crops and only plant one crop continuously, it puts a strain on the soil. Soybean is the "cash crop" for Brazil. In order to continue competing in the international market, most farms will only plant soybeans, bypassing the best practice of rotating crops, and jeopardizing the value of their future crop yields. The agronomist stated, "Corn is a grass; soybeans are legumes." It is a natural cycle where grasses grow and take nutrients out of the soil, and legumes add the nutrients back. If you grow only one crop pests will start to become resistant to the pesticide, and more pesticides will need to be added. There are also risks of overexploitation and contamination of groundwater resources in vulnerable agricultural areas (Franzese et al., 2013). Brazil has plenty of water resources, and groundwater plays a crucial role in supplying cities, towns, industries, and agricultural farming systems. The glyphosate[11] levels for internal consumption are 5,000 times the limit in Brazil compared to the glyphosate levels found in water in Europe. There are some residue regulations, but not enough, so water contamination continues affecting drinking water. Fertilizers, herbicides, and pesticides are sprayed by planes and drones contaminating the air and the areas near the plantations. Most of the

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[11] **Glyphosate** is used in herbicides. It has harmful effects on the ecosystem and is frequently found in surface water and soil. It also endangers human health.

farmers have their houses on the soybean plantations, making them personally susceptible to all levels of soil, water, and air contamination.

3.B.1 SOY MORATORIUM LIMITATIONS

In 2006, the Brazilian Association of Vegetable Oil Industries (ABIOVE) and the Association of Cereal Exporters in Brazil (ANEC), which together purchase 90% of the soy produced in the Amazon, signed Brazil's Soy Moratorium (SoyM) agreement, banning the purchase of soy grown on deforested land (Gibbs et al., 2015). With the help of Greenpeace's research highlighting the destruction that soy production was causing the Amazon, the agreement has been renewed indefinitely. SoyM protects the entire Amazonian Rainforest and monitors it for private companies trying to deforest it, however, the monitoring system is limited to municipalities in the states of Mato Grosso, Pará, and Rondônia where at least 5,000 hectares of soybeans are planted each year. It does not monitor other protected areas and indigenous territories like the Cerrado Biome or Atlantic Forest. The socio-environmental researcher interviewed was able to confirm the slowdown of deforestation in 2006 and the positive effect monitoring has had. His research highlights that SoyM only focuses on the international trade of soybean, not the domestic market in Brazil, which is about 40% of the country's soybean production. After analyzing different municipalities in the Amazon, the ones that are less committed to international trade have higher rates of deforestation and environmental change compared to the municipalities that have a strong connection to international trade. International trade comes with international regulations that must be followed or pay hefty penalties. This is another example of the Brazilian government's focus on areas that will negatively affect international trade while ignoring the larger problem.

3.C. HUMAN RIGHTS

Soybean production has changed Brazil's economy forever. Soybeans have brought new international trade and power to the Brazilian government, but in 2019, 77 million people (37% of the population) living in Brazil still lacked access to basic sanitation. Unemployment and job informality rose during the COVID pandemic. Brazil's government only allowed 1.26% of their federal budget to target poverty reduction programs, the same ratio since 2016 (Civil Society Working Group, 2020). According to the National Brazilian Institute of Geography and Statistics

(IBGE), hunger in Brazil reached more than 5% of the population for the first time since 2013. Which begs the question: Who is benefiting from the agricultural productivity growth of soybean production and trade?

While it was difficult to organize direct interviews with farmers or producers, the interviewees had first-hand experiences interviewing them. Unlike soybean farming in China, where soybean plantations are close together and farmers are neighbors, Brazil's plantations are far apart, and the researchers at times had to travel long distances to reach them. Not everyone is willing to discuss their situation because of fear of losing their job. A specific group of researchers went above and beyond to set up interviews with Brazilian soybean farmers. First a meeting with the Brazilian Agricultural Research Corporation (EMBRAPA), Soy and Maize Producers Association (Aprosoja Brazil) and the National Company of Food and Supply (CONAB). Then, using a snowball sampling approach, they were able to reach out to State groups, such as Aprosoja Tocantins and Aprosoja Goiás, as well as the Agricultural Confederation of each State and other State agencies. Finally, they reached soybean farmers themselves in both states (Bicudo da Silva et al., 2020a). These farmers work very hard and long hours. One farmer said he worked 48 hours straight. During the interviews for this paper, an open-ended question was asked about human rights. The phrase "modern-day slavery," came about. Slavery is one of the worst human rights violations because there are no rights, and a person is considered property. For that reason, slavery's ban is absolute and can never be justified. The agricultural frontiers of Mato Grosso and Tocantins are some of the areas where unfair working conditions and exploiting have been reported. The Landless Workers' Movement (MST)[12] in Brazil has supported farmers reporting injustices such as these. A member from MST stated that major soybean corporations manipulate the market with stock and price speculation. They have managed to transform soy into the main ingredient in animal feed. With support from the government, these corporations have full control over international trade.

Some research has justified the structural economic transformation of other Brazilian agriculture markets, noting how productivity and growth has made agriculture a net job creator (Arias et al.,

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[12] **Movimento dos Trabalhadores Rurais Sem Terra (MST)** in Portuguese, is a mass social movement, formed by rural workers and supporters who fight for land reform, injustices and social inequality in rural areas.

in 2017). They advised agriculture should continue its positive upward trend while being environmentally sustainable, creating jobs, and increasing incomes for the rural poor. Interviewing a research supervisor from the University of Rio who has worked closely with farmers and producers in Mato Grosso and Rio de Janeiro, however, provided conflicting information. In Mato Grosso, local people are not benefiting from the soybean boom. Small farms cannot compete with the industrial farming operations which are more efficient and have more capital.

3.C.1. SOYBEAN TRAP

The global soybean market is controlled by five major companies: Bunge, Monsanto, ADM, Cargill, and Dreyfus. Small farms still exist in the southern region of Brazil, where soybean production first arrived and older, more traditional farming techniques are still in place. A recent 2020 research study by R. Bicudo da Silva focused on how soybean producers can become "trapped" in the agri-business, first coining the term *Soybean Trap in 2016.* Bicudo do Silva found similarities in the interviews he and his team conducted with farmers in Tocantins and Goias and later in Mato Grosso. During the interview, he was able to explain the dependencies the producers had on moneylenders, traders, and input supply companies, also known as agricultural treadmills.[13]

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[13] **Agricultural treadmills** describe a cycle unique to the agriculture industry that makes producers invest in the newest technology to achieve the best levels of production.
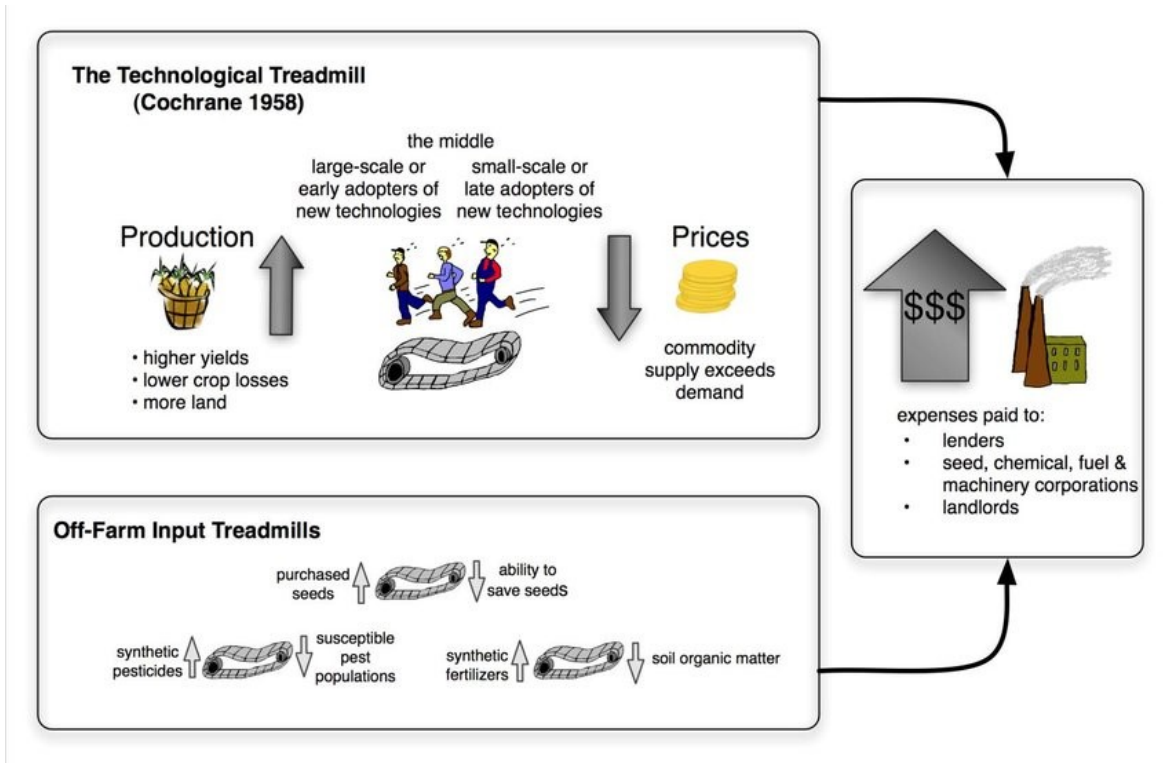
Figure 6. Agricultural Treadmill or Technological Treadmill explains the never-ending cycle producers can get trapped in because of an unsustainable soybean production system. Adapted from Cochrane (1958).

In 2016, a year of *El Niño*, there were drastic changes in weather conditions and producers saw major reductions in their soybean production, similar to what happened to the farmers and producers around the world when the 2019 COVID pandemic began. Natural disasters are not insured in Brazil like they are in many other countries such as the USA. The USA provides debt relief to their farmers and crop insurance that, depending on the package selected, can be insured up to 80%. In Brazil, if a farmer does not produce enough, or produces too much and cannot sell, they go into debt. They still must pay back all the money they have invested in pesticides, workers, mortgage/rent, equipment, etc. This money is usually a loan from a bank. Therefore, producers now need more money to pay off their debt and to stay up-to-date with the newest agri-technology to remain competitive. Some producers do not even realize they are trapped or stuck in this cycle. One farmer expressed to an interviewer that if one year production is bad due to weather or a pandemic, it will be a bad year for all farmers, so prices of soybean will go up. If they are lucky and their farm is not affected for whatever reason, they will sell their soybean for a lot more. They believe that is their ticket out of the cycle. They would be able to pay off all their debt and have

the freedom to do with their farm what they want. That is not that case for many. More than likely, if their debt goes unpaid for too long, a bigger more powerful company will buy them out. That remains the pattern today.

3.C.2. INDIGENOUS COMMUNITIES

There are about 300 indigenous peoples in Brazil, the highest amount in Latin America and the Caribbean. The total national forest area in Brazil is 493.5 hectares, and of that area 118.1 hectares are occupied by indigenous peoples (FUNAI, 2020). The researcher and professor at the University of Rio who was interviewed has worked with 70 families of indigenous people. He is currently researching health problems such as cancer that he believes are caused by residue glyphosate, water contamination, and carbon emissions from soybean production.

Trees in the Amazon not only convert carbon to oxygen, they also constantly capture additional carbon from the atmosphere. From 2003 to 2016, the carbon captured by the indigenous territories in the Amazon Rainforest was equal to 90% of all the carbon emitted from these territories due to deforestation or forest degradation (Walker et al., 2020). In other words, these indigenous territories produce almost no net carbon emissions. A United Nations report determined that deforestation rates are significantly lower in areas where indigenous communities live and assume responsibility for the forest. Safeguarding and strengthening the rights of indigenous people is vital in preserving forests and biodiversity and the fight against climate change.

CHAPTER 4: SUSTAINABLE PRODUCTION OF SOYBEAN

While there is quite a lot of research on soybean production and the issues related to it, there are fewer studies or research on plans for new, sustainable production systems in Brazil. The public research analyzed in regard to organizations who have attempted to pursue plans for a sustainable soybean process (both production and trade), was minimal. Luckily, the interviewees were able to provide relevant information and company initiatives working towards sustainable alternatives. This chapter is dedicated to the people who continue to fight for human rights, animals, and mother nature.

4.A. BRAZIL'S SDGS 2030 STRATEGY AND PROGRESS

Brazil voluntarily participated in the 2017 National Review's political forum on sustainable development, but unfortunately there is very little—or no—public information on their progress towards achieving the SDG goals. *The Civil Society Working Group for the 2030 Agenda* put out a warning to the Brazilian government in the 2020 Spotlight Report based on their analysis of 91 of the 169 global SDG targets with only two showing any progress. Eighty-five SDG targets are focused on social issues in Brazil, and their report indicated that 68% of these targets show no progress at all. After the COVID pandemic hit, many countries have struggled to get back to where they once were. Brazil was one of them, but the pandemic also revealed the inequalities and environmental recklessness the government had been hiding. The following goals and summaries were the only information found on the SDG's Agenda 2030 website listed under Brazil. Surprisingly, they fall right into place with the research of this paper.

Goal 2 – Zero hunger

The Sustainable Food Systems Programme (SFS Programme) initiative was set up to accelerate the shift towards more sustainable food systems such as food value chains and farm to fork. This could have been a giant leap in the direction for a sustainable production of soybeans and many other crops. Brazil has made no progress on this initiative therefore no progress report has been provided.

Goal 8 – Decent work and economic growth

The *Bolsa Floresta* initiative is listed as a reward to be given to communities for their commitment to stop and prevent deforestation. In order for families to receive grants given by the government, they must attend a two-day training program on environmental awareness and make a zero-deforestation commitment. In addition, they must enroll their children in school. It sounds like a great start for social awareness around deforestation and climate change, but once again no action has been taken on this initiative and no progress report has been provided.

Having an international market for exportation of the top commodities, Brazil has the opportunity to build strong partnerships with other countries and progress with SDG goal 17. Instead, Brazil is no longer seen as a friendly supporter of sustainable development and promoter of human rights

(Civil Society Working Group Brazil, 2020). This has negatively affected its budget for international cooperation. Efforts to combat climate change and human rights violations come primarily from civil society and the academic community. The current federal government ignores scientific evidence and local policies.

4.B. BRAZILIAN GOVERNMENT LIMITATIONS

Brazil has been plagued by corrupt leaders and bad governance. Their current president Jair Bolsonaro does not promote sustainable and inclusive economic growth with decent and productive employment for all Brazilians. He is also considered by many an anti-environmentalist. Brazil is unable to guarantee the application of their national laws due to the not having public policy, budget, and staffing laws. President Bolsonaro's lack of leadership and active negligence in protecting the Amazon and the people brought about a lawsuit in 2020. A coalition of non-governmental organizations took the Brazilian government to the Federal Supreme Court demanding that the government comply with the Constitution, which protects present and future generations as well as the Amazon Rainforest. The government controls the resources therefore soybean producers seek to attain privileges within the economic activities. These conditions have led to greater levels of corruption in Brazil. Weak institutional quality combined with increased corruption negatively affect the economic growth of a country.

4.C. SUSTAINABLE ALTERNATIVES

There is high demand for soybean for many reasons, as this research paper has shown, but there must be sustainable alternatives that can help Brazil's economy grow without destroying the land and the people who live from it. The following alternatives and recommendations will provide the support soybean plantations need to continue operating, sustainably, ensuring no more environmental degradation and human rights infringements.

1. **Local Policy:** Local policies should be in place that enable individual producers to make environmentally and financially sound agricultural decisions. This is vital to ensure a sustainable soybean system and not trap producers in an endless cycle of debt and investment (Silva et al., 2020). This protects the farmers, producers and workers so that

they receive fair pay and working conditions. Also, agreements such as the SoyM have proven to be a powerful tool in international trade and will also be beneficial in local markets. More agreements should be signed, and penalties paid to environmental programs if not adhered to, in the fight against deforestation.

2. **Incentive Packages:** Designing and promoting incentive packages for restoration, conservation, and sustainable use of forest resources; promoting private sector participation in the development of production chains aimed at reducing deforestation and forest degradation while increasing the benefits of farmers and their communities.

3. **Regulations:** Glyphosate regulations on how much can be used on crops must be regulated to stop the contamination of the air, water and soil. Other pesticides as well must be regulated, and farmers should have more natural and sustainable options such as non-GMO seeds.

4. **Crop Rotation:** Soybean rotation with another crop such as maize benefits both the farmer and the environment. It has been tested and is preferred to continuous cropping because it produces greater yields for both crops. It also reduces input costs, and farmers are able to use less nitrogen fertilizer (Singh, 2010). Reduced stress from pests and diseases is always beneficial to the environment.

5. **Partnerships**: Partnering with organizations such as ProTerra Foundation, Soy Transparency Coalition and other Biotech and Green Technology companies provide support and set up long-term strategies to build a sustainable food production system for soybean plantations.

6. **Crop Insurance:** Insurance options should be available for farmers and producers in case of unforeseen circumstances and natural disasters.

7. **Re-forest:** Re-foresting deforested areas and adding secondary forests plants back the trees and vegetation that was lost. It helps curb the CO_2 emissions while providing homes to animals and maintaining the biodiversity.

8. **Irrigation:** Irrigation with a drip system allows for slow and permanent water flow. This practice reduces water consumption, incidence of fungicides and weeds, and improves overall yield quality.

9. **Green Fertilization**: Cultivation of plants which will be transformed into a green mass and incorporated to the soil to enrich it with more minerals and organic matter. Helps to prevent erosion and post-harvest lixiviation. Composting is also another green fertilizer that can be produced from organic wastes. The technique helps to increase productivity and reduce costs for the farmers.

10. **Technology:** Affordable and sustainable technology that farmers and producers can use on their plantations that will allow them to use clean energy, one example of this is solar powered panels.

CHAPTER 5: CONCLUSION

The findings in this paper show a strong connection between soybean production and environmental destruction. The increased global demand for more soybean faces major challenges. The world population continues to grow, an estimated 9.55 billion people for 2050 (FAO, 2014). The increase in income leads to changes in people's diets, mainly towards more meat consumption which puts pressure on land availability. Finally, climate change, as more carbon emissions are released in the atmosphere, the earth will experience less rainfall and global warming. Agricultural production emits nearly one-third of the world's total carbon dioxide. The rainforests and savannas' biodiversity are in danger and so are humans.

Soybean production involves a series of economic, environmental, and social impacts, the advantages and disadvantages are unevenly distributed throughout society. The Brazilian people and indigenous communities are suffering the repercussions. If sustainable alternatives are not adopted, the entire world will suffer as well. Countries have to work together against a corrupt

Brazilian government who puts financial gain before transparency and leadership. It is critical for these challenges to be addressed by worldwide policies, along with local policies for production and trade. The world cannot continue to turn a blind eye. Many Brazilians are working hard towards a sustainable standard of soybean production. They have innovative ideas, and the sustainable alternatives exist. With the help of public Brazilian entities, organizations and international partnerships they can enforce sustainability in Brazil and provide a new fair production system for all.

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ANNEX

Table 1. Shows the experts interviewed their relationship to the topic of research.

OCCUPATION	INSTITUTION/ COMPANY	RELEVANCE TO THE RESEARCH
Ramon Bicudo da Silva		
Socio-environmental researcher and professor	• Michigan State University (US) • State University of Campinas (BR)	He is a Brazilian researcher with a PhD in Environment and Society. A *Google Scholar* with 51 publications. He also has experience as a socio-environmental researcher with a focus on the human dimensions of environmental change. His research deals with qualitative and quantitative analysis concentrated on socioeconomic and ecological data. His fieldwork's concentration is in modelling, statistics, spatial econometrics, socioecological (design and data collection), GIS & remote sensing, and policy analysis are my major skills. He is one of the contributors to the published journal "Soybean Trap."
Anna Herzberger		
Technical Agronomist	• GROWMARK Inc	Born and raised in the United States she grew up on a corn and soybean farm in Illinois. She is an American chemist with a Ph.D. in Systems Integration. She has experience providing agriculture-related products and services, as well as grain marketing in the Midwest and

		Ontario, Canada. Works with farmers offering them crop inputs and energy-related services.
Mônica Vianna		
CEO and Agro-environmental Researcher	• SØLLYTCH • University of Rio, Brazil (Nova Friburgo Laboratory)	With 20 years' experience working with producers, her degree is in Biological Sciences and her master's degree and PhD is in Analytical Chemistry. She completed her postdoctoral studies at EMBRAPA with mathematical modeling in the Mechanical Testing and Metrology lab. She served as supervisor of the Integrated Laboratory of Agro-Environmental Analysis. Her research activities involve analytical applications of agro-environmental interest: development and validation of analytical methods and optical biosensors for pesticides. She is the CEO and founder of the startup SØLLYTCH, where her and her team work on chemical and biological analysis and cutting-edge research to develop sensors and biosensors to provide strategic data for producers.
João Paulo Torres		
Research Supervisor	• SØLLYTCH • University of Rio, Brazil (Nova Friburgo Laboratory)	Brazilian research supervisor and Professor at the Federal University of Rio de Janeiro. He has a PhD in in Biological Sciences. He is a member of the Brazilian Society for the Progress in Science. He also has experience in Environmental Biophysics, acting on the following topics: environmental pollution,

		DDT, PCB, organochlorines and environmental contamination. He works with farmers and does soil analysis at a test farm in Nova Friburgo, which is a vegetable and legumes production town. He has done research on indigenous communities. He is the project manager at SØLLYTCH, a company that provides intelligent traceability services for production, enhancing management and its sustainable impact.
Erica Lima		
Director	• SmartBio do Brasil	She has 10 years working for a multinational Green Technology company as executive assistant and Marketing manager. She works closely with research source EMBRAPA. Using years of research, she has started her own Startup company to markets and sells the best possible production systems to farmers, an opportunity for them to be more sustainable and to use less agro-toxics in their productions.

INTERVIEW QUESTIONS/SCRIPT:

Hi _____ before we get started I wanted to thank you so much for taking the time to help me with my research.

I also wanted to give you a little background on why I decided to choose this topic.... *(Read objectives and explain motivation.)*

1. Before we jump into my specific research questions, can you tell me a little bit about yourself and any research you have been involved with on this topic or the level of familiarity you have with this topic.

2. What is your job title and duties?

3. Have you worked with any Brazilian soybean companies?

4. What direct connection does soybean farming have with deforestation?

5. Explain GMO vs non-GMO soybeans.

6. Have you worked with any Brazilian farmers or producers?

7. Thinking specifically about human rights, what issues have a strong correlation between soybean production and human rights violations in Brazil?

8. What outcomes do you believe are most important to include in my research?

9. What kinds of sustainable production systems of soybean are there?

10. Are there any emerging areas of research or alternative strategies for managing soybean production?

11. Are there better ways to express any of these research objectives? What suggestions do you have to improve the clarity of the wording?

Thank you again for your participation.