The Impact of the Agro Sector on Climate Change: a comparison between the Global South and the Global North. Analysis of Mexico, Brazil, the Netherlands, and the United Kingdom.

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Contents

Abstract

The Agro sector and its industry are among the largest contributors to climate change (Loboguerrero, 2019). Climate change is impacting disproportionally countries of the Global South compared to those of the Global North. In particular, the Agro sector is prominent in the Global South due to Western countries' investments as well as import and export trends that are rooted in the history of colonialism. Both statistically and historically speaking, the Global North is bigger perpetrator of environmental disruption and exploitation than the Global South. This hyper globalised pattern, created and promoted by wealthier countries, is being "exported" in the Global South countries, which are those bearing the burden of it. For this reason, the Global North must take on more responsibility through the implementation of effective environmental policy and regulation. A drastic reduction of globalised commerce, which has proven to be detrimental in terms of its impact on the climate, is necessary too. Taking concrete strong action is obligatory to stop, or at least attempt to slow down, the climate disaster from worsening.

In this thesis, the Agro sector will be explored: when did it start to be a global business? What impact does it have on the environments and its populations? The issue will be explored considering both environmental and social sustainability will be.
The expansion of such sector the Global South will be investigated historically and politically. This will be an attempt to individuate the role of the Global North in this process. The impact of Agro industry in the Global South will be presented using some case studies. Among them water depletion and virtual-water trade in Mexico will be considered. Moreover, the case study of tropical fruit trade between South America and Northern Europe will be introduced.
Lastly, there will be an argument for the Global North taking responsibility to largely limit the impact of the Agro sector. What policy can be implemented to even the Global North and South disparities and to limit the impact of this sector on climate change?

Introduction

Problem statement

Research reports that the Agro industry is among the largest contributors to the worsening of climate change (Lynch et al., 2021). The Agro industry being defined as the following:

"The Agro-industry is a broad concept that refers to the establishment of linkages between enterprises and supply chains for developing, transforming, and distributing specific inputs and production in the agricultural sector." (FAO, 2007).

The Agro sector is prominent in the Global South. Firstly, due to this area's environmental and biodiversity characteristics, with large and fertile areas of soil allowing agriculture to flourish. Secondly, the Global South plays a key role in the import and export trends of global trade, many of these processes being rooted in the history of colonisation in the region (Gokmen et al., 2020).

Agriculture, food production, exportation mechanisms, and the Agro industry more broadly, are part of a huge economic net that has a concerning impact on climate change. Research shows that 26% of greenhouse gas emissions come from food, 70% of global freshwater withdrawals are used for agriculture, and that 78% of global ocean and freshwater pollution is caused by agriculture (Ritchie, 2019).

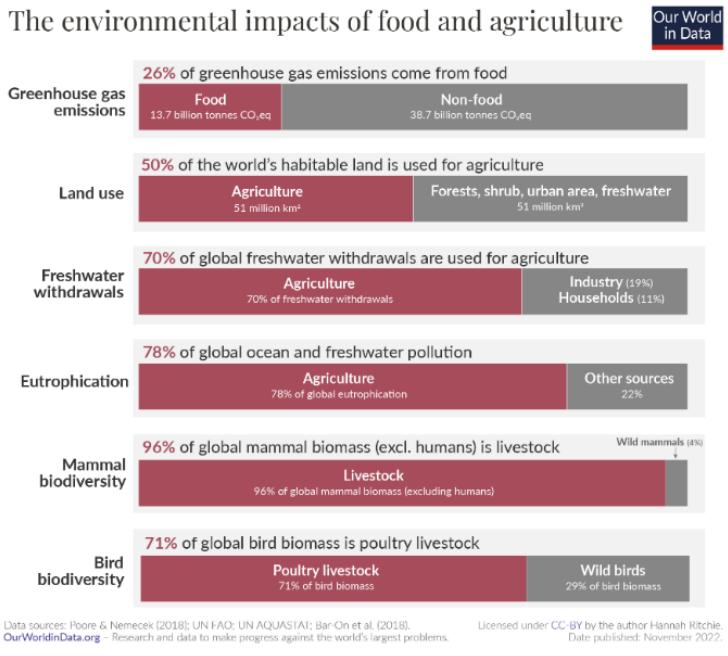


Figure 1: *Sector by sector: where do global greenhouse emissions come from?*
Source: Ritchie, H. (2020). Our World in Data.

The figure above shows the environmental impacts of food and agriculture and the main global impacts of the Agro sector. It allows one to grasp the effects of this industry on the

worsening of climate change. Undoubtedly, agriculture and food production are at the core of the issue. Reducing the impact of this sector would mean decreasing water stress, restoring lands back to grasslands/forests, protecting wildlife, and repairing biodiversity (Ritchie, 2019). In particular, the area of Central and Southern America plays an enormous role in agricultural activity and food production in the world. For instance, sugar crops are widely diffused in this area as indicated by the graph below.

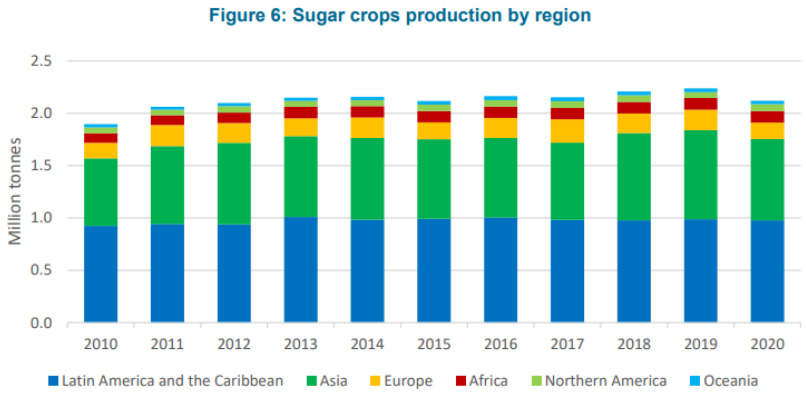


Figure 2: *Sugar and crops production by region*
Source: FAO. (2020). FAOSTAT Analytical Brief 55. Food and commodity balances 2010-2020.

Academic relevance

This thesis aims at exploring the history, development, and current functioning of the Agro industry. When did agriculture start to be a global business? What is its impact on the environment, on its workforce and more broadly on people?

The expansion and trends of this industry and their links to the Global North and Global South will be investigated both historically and politically. The impact of the Agro industry on climate change in the Global South will be explored through case studies that exemplify the issue at hand. These being that of water depletion in Mexico and of avocado trading between South America and Northern Europe. The Global North's role in the Agro industry and on its impact on climate change more broadly will be investigated. As well as the issue of who ought to take responsibility to limit the impact of the Agro sector and the climate disaster. With concluding thoughts leading us to asking what policy can be crafted to level out disparities between the Global North and South to limit the impact of food production on climate change?

This research is a relevant addition to academic literature for two main reasons. The first reason being that this thesis ties up the economic, political and philosophical discourses around the impact of the Agro sector on climate change. This interdisciplinary approach allows us find cross-disciplinary aspects that would otherwise go unnoticed with a traditional analysis e.g., solely economic. Furthermore, the combination of more disciplines makes it possible to summarise the findings in the context of politics, namely translating them in policy solutions. Overall, the significance of this research does not only lie in its content but comes from the methodology employed. The second reason why this study has an academic relevance is related to the discussion it aims to provoke. This thesis aims at investigating the phenomenon described in the problem statement but also at stimulating a debate around it. This is relevant in the current political realm as governments are facing increasing two intertwining phenomenon that must be addressed. On the one hand, there are important trends of growing populations which imply that higher food production are required. On the other hand, governments have to face consequences of climate change. As a result, the combination of population growth and climate change make the debate around food production necessary to address both issues. Many research questions lie at the base of this study, some apply narrowly to each discipline, with others encouraging cross-discipline discussion.

Research Questions

This research will be structured around three main research questions, which will be briefly introduced in this paragraph.

In the context of the Agro-sector, to what extent is the Global North exploiting the vulnerabilities of the Global South in order to gain advantage?

The issues created by the Agro-system will be examined from a philosophical-ethical perspective. This question's aim is individuating some existing disparities between the Global South and the Global South in the context of the Agro-sector.

How has the Agro-sector of the Global North exported its emissions to the Global South?

The purpose of this research question is to collocate the disparities brought by the Agro-system in the context of the economic relation between the Global South and the Global North both historical and current.

To what extent does the responsibility lie with the Global North in addressing the environmental and social issues of the Agro-sector?

This question will explore existing power dynamics between the Global South and Global North in the Agro-industry, with the aim of understanding where the responsibility of addressing environmental issues lie.

These three research questions have been designed to approach the analysis that will follow in an interdisciplinary manner. This suits the type of research that we are conducting because the Agro-sector is incredibly multi-faceted as it includes a wide range of processes and actors. Therefore, analysing this industries in a multidisciplinary fashion will provide us with a greater depth of understanding of the issue that it faces. Moreover, this research questions will allow us to examine the Agro-sector through the global power dynamics at play, the economic forces that dominate the industry as well as the ethical concerns related to the disparities in power that exist within this sector.

Executive Summary

The first chapter will aim to provide context and background to the issues and concepts that will be discussed in this thesis. Firstly, the Global South and Global North divide will be introduced, with the history of colonialism and international exchanges being a focus. The intricacies and the contested nature of this concept will be explored looking at the complex causalities, including economic inequality, resource distribution, population growth trends and more. Following this, the link tying this phenomenon to climate change will be examined, as well as investigating ethical concerns related to this topic. Secondly, there will be a section on the definition and history of the Agriculture Food Supply Chain (AFSC). Again, the links between this global system and climate change will be explored. Thirdly, a section of the first chapter will be devoted to the statistics on the impact of Agriculture on Climate Change. In order to facilitate this, greenhouse gas

emissions will be used as a yardstick. Lastly, the section titled "The modern Agro business" will present the latest developments of the AFSC system from the 20th and 21st centuries. In particular, the Green Revolution at the end of the last century will be examined.

The second chapter will examine the Agro sector in detail. From an economic point of view, the role of the sector in global business will be investigated. The latest developments of the industry, earlier introduced in Chapter 1, will be further explored, particularly, the mechanisation of agriculture, irrigation practices and the usage of fertilisers' will be considered. Following this, the issue of population growth will be brought to the forth, leading to the key question: How can agricultural output meet food demand which is increasing proportionately to the increment of the world's population? Some research fields such as Agroecology will be named as potential contributors to address the problem. Ethical concerns related to food distribution at the global level will be introduced. Some potential solutions to the impact on agriculture on climate change and to the Global South and North divide will be looked into. Strategies such as crop rotation, conservation tillage, and improving efficiency of livestock production are some of these solutions. Bioenergy and renewable energy are other available options. The following section of Chapter 2 will deal with the geopolitics of the Agro-industry. In this instance, Global South and Global North will be, once again, at the centre of the discourse. Their relative economic disadvantage and advantage will prove necessary in order to understand the social unsustainability driven from this divide. Specifically, the states of Northern Europe and Southern America in terms of Agri-sector will be introduced. These geographical areas will be central in the analysis of the upcoming chapters. Before going into depth in the cases of Mexico, Brazil, the Netherlands, and the united Kingdom, some concluding remarks on the status of the global business of the Agro-sector will be drawn.

The third chapter of this thesis will be gathering statistical data on the impact of the Agro industry on Climate Change in different countries of the world. The concept of the nation-state will underpin the analysis. The approach to this section will be political nd economic, for this reason classical international theory will be employed to look at

counties separately. The chapter will be subdivided into two major sections. The first, will look at the environmental performance of world countries alone. Some explanatory graphs will serve the purpose of understanding which countries impact the most on climate change due to their agriculture activity. In addition, other figures will highlight which agricultural practices are the worst in terms of their environmental impact. The Environmental Performance Index 2022 (Yale Centre for Environmental Law & Policy, 2022.) will be used as a key source of information. The second section of Chapter 3 will consider the agricultural exchanges between some selected countries – precisely two from the Global South and two from the Global North – with the aim of grasping the indirect environmental effects these may have on one another and on climate change. The countries considered will be Mexico, Brazil, the Netherlands, and the United Kingdom. There will be a table "scorecard" per country indicating their environmental performance according to several indicators. For instance, biodiversity, agriculture, and water resources. Afterwards, the data of the four countries will be compared.

Chapter 4 will investigate in the business of the Agro-sector in the context of a global market economy. To do so, the analysis will consider the import and export of Agro produce in several countries. There will be a brief overview Agro-sector flows globally. Followed by an extensive analysis of import/exports of Brazil, Mexico, the Netherlands, and the United Kingdom. Finally, an attempt to link this data will be made. By doing this, it will be possible to understand the links between these countries in the context of the Agro-sector. Beyond this, this research will try to discover the indirect impact of a country on the environmental state of another. For instance, if a country imports a given quantity of Agri produce from another state, what is the indirect impact this exchange has on the state of climate change in the exporter country? This section will therefore serve as an insightful point of departure, for further studies on the indirect impact international Agro-sector trade can have on climate change and on more vulnerable areas. This chapter will end with some conclusions and explanation of the limitation of this analysis.

The fifth chapter of this thesis will be devoted to the case study of water depletion and virtual water trade in Mexico. The aim of the chapter is to use this case study to exemplify two claims: the first being the impact the Agro-sector has on climate change, the second

being to what extent countries of the Global South suffer a relative disadvantage compared to those of the Global North. This section will give a gist of the areas of the world that have been main CO2 emitters historically. Afterwards, the discourse around the resource of water in the world and in Mexico will be deepened. The concept of virtual water will be explained and there will be several remarks on the role this resource has within the global market of the Agro-industry. This analysis will lead to the discourse around the Global South and North divide, particularly considering the availability and distribution of resources.

Many scholars argue that climate change is disproportionately impacting the countries of the Global South and their populations compared to those of the Global North. In particular, both statistically and historically, countries of the Global North are blamed to be responsible for environmental disruption and human exploitation connected to it (Exenberger & Hartmann, 2007). In other words, a hyper globalised pattern of production and distribution has been *exported* to the countries of the Global South. For this reason, it can be argued that the Global North ought to take responsibility for this catastrophe. To do so, these countries should implement effective environmental policies such as drastic cuts on globalised commerce which has a detrimental impact on the climate. This research is concerned with individuating the causes of the worsening of climate change that are linked to the Agro sector, and paraphs, to suggest concrete steps to slow down the climate disaster from worsening.

Chapter 1: Historical Background

The Global South and North divide

The Global South and North divide is a contemporary concept of a gap existing between two macro areas of the world in terms of wealth and development. In the 1980s, to explicate this global pattern, the Brandt Line was developed (ICID, 1980). The line was drawn with the intention to show graphically the world's split into "more developed" and "less developed" nations.

Figure 3: *The Brandt Line*
Source: ICID Independent Commission on International Development. (1980). *North-South, a programme for survival: the report of the independent commission on international development issues*. Pan Books.

Initially, as it is noticeable in the map above (Independent Commission on International Development, 1980), this model located poorer countries mostly in the Southern Hemisphere, and wealthier ones in the Northern Hemisphere. The caveat being the noticeable exception of New Zealand and Australia. Nonetheless, recently, the Brandt Line model is often being considered slightly obsolete for its simplicity. It is now preferable to look at maps showing the divide North/South based on the nations' GDP per capita (PPP), as shown in the figure below (ICID, 1980).

Figure 4: *The New Brandt Line*
Source: ICID Independent Commission on International Development. (1980). *North-South, a programme for survival: the report of the independent commission on international development issues*. Pan Books.

Having said that later representations better capture the so-called South/North divide, quantifications in terms of GDP per capita can sometimes be misleading. For instance, countries that have recorded incredibly positive economic growth in recent years might also hide big economic inequalities within the country itself. For this reason, carefulness is required when dealing with economic, social, and environmental inequalities.

Despite the fact that in the last two centuries developments have raised millions of people out of absolute poverty, inequality is still growing substantially. Therefore, it continues to be relevant to look at the Global South and North gap. Some data reports that the average income in 1820s Western Europe was three times bigger than the African average income, but by the year 2000 it was thirteen times bigger (RGS, 2012). Inequality between wealthier and poorer countries keeps growing, despite minor improvements in the less wealthy ones (Cingano, 2014). Today, the world's South/North gap is much more complex than that indicated by the original Brandt Line. However, researchers use the terms Global South and Global North referring to richer or poorer countries which can be located both within or without the traditional division. Having said this, it is crucial to underline, once again, that a country's GDP can sometimes be misleading owing to the fact that important inequality within one country risks being ignored. For example, India has got a substantial middle class and very rich elite among its population. Nevertheless, this country is also the one with the largest concentration of poverty in a single nation (ibid.).

In relation to climate change, the Global South/North divide is related to the losses and gains that countries make because of climate change itself. Having said that economic growth is a clear driver of climate change, more developed countries of the Global North continue to push towards this trend (Paulson, 2022). This makes the Global North the main perpetrator of climate degradation. This causes several environmental problems, as well as social ones. In fact, countries of the Global South are primarily bearing the burden of uncontrolled economic growth, mostly driven by the Global North. Although dominant macroeconomic theories assume that economic growth provides the resources for both social and environmental protection, such assumption is argued by some to be weak (Rosales, 2008). Without political corrections, economic growth for the sake of itself does

not address the South/North divide but raises equity concerns. To better grasp the inequality between more and less developed countries, more than twenty years ago, Henry Shue tried to apply ethical principles when deciding how to distribute the cost of global environmental degradation. Two of the ethical postulates are the following:

> "Since they have the biggest resources, and according to the *ability to pay principle*, the Global North shall contribute to mitigate climate change to a greater extent compared to the Global South" (Shue, 1999).

> "When climate change costs are imposed by wealthier countries onto the Global South ones without the consent of the latter, the Global South shall have the right to demand the North to take responsibility for mitigation and adaptation" (ibid.).

This second postulate follows the *principle of polluters pay*, and that of *common but differentiated responsibilities*.

Currently, economic growth is producing detrimental Green House Gas (GHG) emissions in poorer counties while giving the richer ones disproportionate benefits (Porter et al., 2016). In addition, the less developed countries have a limited capacity to respond to the climate change calamity. In this sense, it is possible to see the Global North as the 'inequality producer' on whom the burden of climate change should fall upon, according to ethical fairness. Nevertheless, for the time being, richer countries are not bearing the burden of climate change's most direct catastrophes, nor contributing effectively to lift such burden off the shoulders of less wealthy countries (Beckerman et al., 2001).

As the graph below shows (Baumert & Pershing, 2004), in the last century countries in the Global North e.g., USA, UK, Germany, have decreased their cumulative Co2 emissions, while countries of the Global South e.g., Brazil, Argentina, have increased them. This could be seen as a result of hyper globalisation and to the industries' of the Global North relocating to countries that provide cheap labour and raw materials, such as those of the Global South. This process of outsourcing has led wealthier countries to progressively reduce emissions while causing a rise of the same in poorer countries.

Therefore, said countries are now suffering the most from climate change and its catastrophes such as hurricanes, floods, and droughts.

Cumulative CO_2 Emissions

1850–2000 vs. 1990–2000

Top 25 emitters

	Percent of World (Rank)				
	1850–2000		1990–2000		% Change
United States	29.8	(1)	23.5	(1)	–21
European Union (25)	27.2	(2)	17.3	(2)	–36
Russia	8.3	(3)	7.8	(4)	–5
Germany	7.5	(4)	4.0	(6)	–46
China	7.3	(5)	13.8	(3)	89
United Kingdom	6.5	(6)	2.5	(8)	–61
Japan	4.1	(7)	5.2	(5)	28
France	3.0	(8)	1.6	(13)	–45
Ukraine	2.3	(9)	2.1	(9)	–8
Canada	2.1	(10)	2.1	(10)	–3
Poland	2.1	(11)	1.5	(14)	–27
India	2.0	(12)	3.7	(7)	80
Italy	1.6	(13)	1.9	(11)	18
South Africa	1.2	(14)	1.5	(16)	27
Australia	1.1	(15)	1.3	(17)	24
Mexico	1.0	(17)	1.5	(15)	60
Spain	0.9	(20)	1.1	(19)	30
Brazil	0.8	(22)	1.2	(18)	60
Korea (South)	0.7	(23)	1.7	(12)	138
Iran	0.6	(25)	1.1	(20)	93
Argentina	0.5	(28)	0.5	(32)	14
Indonesia	0.4	(29)	1.0	(21)	114
Turkey	0.4	(31)	0.8	(25)	89
Saudi Arabia	0.4	(32)	0.9	(22)	125
Pakistan	0.2	(47)	0.4	(37)	112
Developed	**77**		**62**		**–20**
Developing	**22**		**38**		**73**

Note: Includes CO_2 from fossil fuels and cement only.

Figure 5: *Cumulative CO2 Emissions Percent of the World (Rank)*
Source: Baumert, Kevin. & Pershing, Jonathan. (2004). Climate Data: Insights and Observations.

The Agriculture Food Supply Chain

Commonly referred to as the Agro sector, Agro business, or Agro industry, the Agriculture Food Supply Chain (AFSC) is a complex system which indicates the combination of processes from production to delivery of Agri-produce (Yadav et al., 2021). Nowadays, such system is hyper-developed and characterised by several stages among which production, processing, storage, and distribution. Moreover, its complexity lies in the considerable number of stakeholders involved in the process, such as farmers, consumers, agricultural suppliers, food processors, distributors, governments, international institutions, NGOs, and so forth (Viswanadham & Kameshwaran, 2013).

Furthermore, the AFSC is an intricate apparatus, not only for the actors involved, but also due to the weight of macroeconomic demand of the contemporary globalised food market. In fact, consumers expect the Agro-industry to be flexible and provide a vast selection of products all year long, regardless of seasonality or agricultural availability. As a matter of fact, the market demands access at anytime and anywhere, of a fan of options ranging from processed to fresh food (Zhu et al., 2018).

Lastly, due to steady increase in world population and overall wealth, food demand has been rising as a consequence. As a result, additional natural resources e.g., water, soil, energy, etc, are needed to meet such demand. It follows that the AFSC is under constant pressure due to increasing demand, rising population, and complexity of its apparatus. In short, the contemporary Agriculture Food Supply System Chain – due to its high energy

consumption features, and the economic and social issues it then reproduces – represents a threat for the ecosystem and the environment (ibid.).

The graph below (Yadav et al., 2022), pictures the current model of the Agro industry. On the left side there are Stakeholders, Sustainability, and Prominent Challenges boxes, and, on the right hand side, some steps employed to make the AFSC more sustainable.

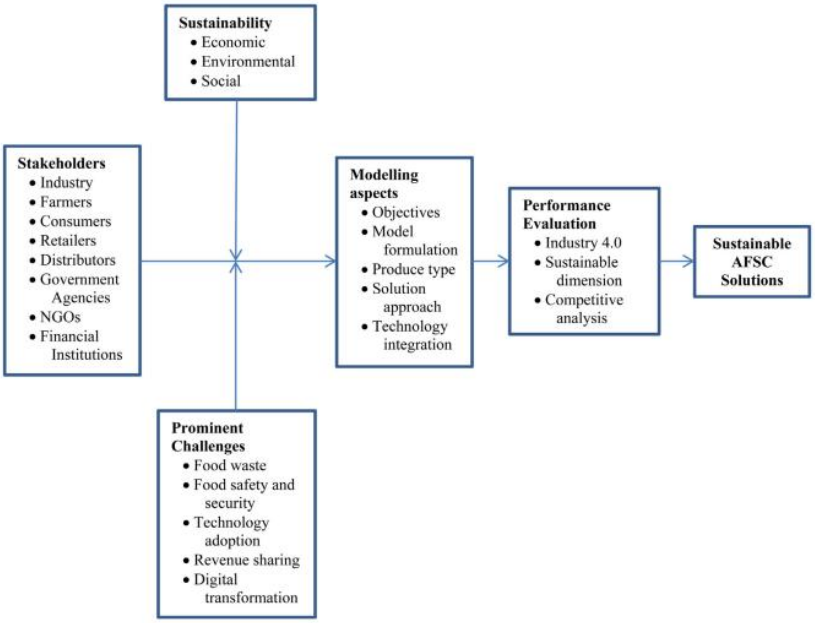


Figure 6: *Research framework for sustainable AFSC solutions*
Source: Yadav, V. S., Singh, A. R., Gunasekaran, A., Raut, R. D., & Narkhede, B. E. (2022). A systematic literature review of the Agro-food supply chain: Challenges, network design, and performance measurement perspectives.

The complexity of the system can be demonstrated by looking at the number of stakeholders involved in the process, e.g., government agencies, financial institutions, retailers, etc. Moreover, the urgent challenges such as food waste and security, together with the sustainability issues, show the challenges posed to a system that currently cannot be seen as sustainable socially economically, nor environmentally. At the same time, this system remains necessary for the sustenance of the world population. To summarise, the main challenges facing the AFSC system are food waste, food safety and security, information asymmetry among areas of the world, and issues incorporating suitability (Yadav et al., 2021). In the following chapters, a more in-depth analysis will be devoted to information asymmetry and inequality among different regions of the world. Namely, the North-South divide is a straightforward instance of such discrepancy.

This being said, the system of food production and delivery conceals and creates several issues from environmental degradation to economic and social inequality, investigating who or what the responsibility weighs upon is crucial. In particular, when the focus is environmental sustainability/unsustainability, GHG emissions can be a yardstick to understand what the situation is.

The graph below (Ritche, 2020) shows global greenhouse gas emissions by sector in 2016. It might be a useful insight to grasp the extent of the impact on the environment caused by the Agro industry. More than 18% of the overall global greenhouse gas emissions are caused by Agriculture, Forestry, and Land Use (Ritche, 2020). Additionally, energy use in industry, road transport, shipping, aviation, food & tobacco, and commercial, are to be considered as well in the AFSC production chain total emissions. Therefore, it can be argued that the overall impact of the sector on climate change is even greater.

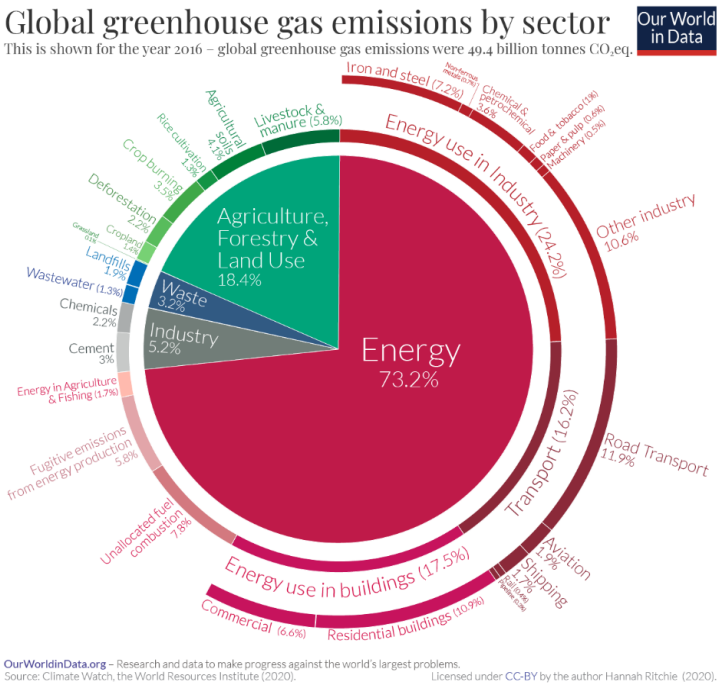


Figure 7: *Global greenhouse gas emissions by sector*
Source: Ritchie, H. (2020). Sector by sector: where do global greenhouse emissions come from? Our World in Data.

Moreover, the percentage of energy in agriculture & fishing is to be considered too. In short, the AFSC is a complex and articulate production line, its impact on the planet occurs at every stage of the chain, and its processes cross various polluting sectors. Agricultural produce and food production are responsible for a very elevated share of greenhouse gas emissions, water depletion, waste, and energy usage.

Nonetheless, this industry is destroying the environment because of the emissions and the market it produces. Because of hyper-globalisation, the AFSC has become progressively almost solely owned by the mass-market giants (Hueth et al., 2006). As a result, as the

competition rises dramatically, the prices for consumers are very competitive too. This impedes smaller and local producers to even have access to the marketplace. Nowadays, the Agro industry operates an oligopolistic market where production, distribution, and prices are decided by a handful of influential companies (ibid.), which in turn causes small and medium size producers to be cut out of the competition. Not only, but this oligopolistic feature risks overlooking environmental concerns as well. Profit-oriented businesses are not concerned with the environmental cost of their actions and having a few powerful companies ahead of a whole production sector might result in a total dismissal of the sustainability problem. All in all, it is worth investigating the functioning of the AFSC in order to identify and limit both social and environmental sustainability issues.

The history of the AFSC

The history of the Agro business and its development, as they are understood nowadays, is relatively recent; but agricultural activity and food production are means of sustenance that have characterised human history since its primordiality. Humankind were those discovering the potential of cultivation on-demand, after thousands of years of hunter-gatherer lifestyle. Regarding what concerns this research, agricultural extension is a concept worth exploring. Agricultural extension is a development and crucial social innovation that has occurred through history. In the Agro-sector field, agricultural extension is seen as the motor for the AFSC development. Some researchers have defined it as the extension of a system facilitating communication and interaction between farmers and organisations and businesses, as well as better access for farmers to technology and agricultural-related information e.g., organisational, and managerial skills, technological practices for irrigation, etc (Christoplos et al., 2012).

The most modern forms of agricultural extension date back to the 18th century, and the oldest 1800 B.C. For instance, ancient records found in Mesopotamia show clay tablets on which information on watering crops and rat elimination were carved to advise farmers and prevent potential losses of crops and taxation revenue (Malgie et al., 2018). Some relatively more recent forms of communication and agricultural extensions were found in

the Egyptians columns. Nevertheless, a crucial moment for agricultural extension was the beginning of agricultural writings during the ancient Greek and Phoenician civilisations, then adapted by the Romans (White, 1977).

Despite these innovations having deep historical roots, the system as we know it today is the result of changes developed in the past two centuries (Jones, 1981). In Europe, and in particular in Ireland, it was the crisis of potato blight that resulted in famine and forced the European countries to evolve their agricultural modes of production (Zadoks, 2008). In the second half of the 19th century, the European model was exported from the United Kingdom to other European countries such as Germany and France, following this the new processes were exported globally to South America. Later, extension programmers reached Japan, then Australia, and Africa around 1914. In short, European colonial powers exported their modern Agro production patterns to overseas territories that they saw as a resource of agricultural and tropical agricultural production areas, to then importing Agro-based industry raw materials (Lucas, 1913).

While the Agro business was being exported by Europe to the rest of the world, European agriculture was undergoing an even further process of agriculture industrialisation and rising in large-scale commercial farming, the latter beginning in the 20th century. A large shift in modernisation of industrial agriculture followed in what was dubbed the "Green Revolution" in the 1950s and 1960s. The new industrial agriculture aimed at increasing productivity through synthetic fertilisers, pesticides, and high-yielding crop varieties.

Today, following a past colonialist model imposition, agricultural extension has been challenged and is therefore changing, becoming slowly more aware of its roots. Contemporary agricultural extensions still include socially sanctioned practices, but also legitimate ones (Jones, 1981). In the second scenario, extensions try to empower agriculturists and local communities by adopting more efficient technology and adjusting to social needs and environmental conditions. Nevertheless, the path towards a fair system of agriculture and food production is still extremely steep and the system continues to be often unethical.

The modern Agro sector

The Green Revolution of the 20th century increased mass scale agriculture production and had some short-term benefits such as increased crop yields and improved food security in some areas of the world. Nevertheless, it also represented the start of an auto-reproducing system of inequality and unsustainability.
The latest development of the AFSC system brought environmental and social inequalities, issues, and concerns. This is due to several reasons among which the concentration of land ownership (Pingali & Roger, 1995). The Green Revolution aimed at maximising profit through economies of scale which led to the concentration of land ownership in the hands of a few large agribusinesses. As a result, a displacement of small-scale farmers occurred since these were unable to compete with large-scale operators and stakeholders.

Secondly, the Green Revolution made industrial agriculture heavily dependent on artificial fertilisers, pesticides, and other inputs that turned out to be very costly economically as well as environmentally, and that are arguably dangerous too. Such inputs' dependence made the Agri business enter in a cycle of debt and dependence (Tilman et al., 2002). In addition, this new trend worsened the relations among the Agro sector's stakeholders e.g., farmers and pesticide's industries, in a way that large firms' income, investment and financial flows rose at the expense of the medium/small size ones.

These trends led to the third effect of the change brought by the Green Revolution: social inequality. The concentration of landownership together with the dependency on inputs, established an increasingly unequal system of production. In this context, huge businesses hold most of the power and make enormous profit, while smaller firms, cooperatives, family businesses, and local small-scale farmers struggle to make a living out of their activity.

Furthermore, the Green Revolution worsened the impact of the sector on the environment. Due to the intensive use of fertilisers and pesticides, the soil condition exacerbated leading to erosion and reduction of soil fertility which resulted in the phenomenon of soil degradation (Gomiero, 2016). In this scenario, farmers are forced to employ even more pesticides in order to maintain yield. As a result, dependence on inputs increased even

more and degradation worsened. Additionally, the new inputs in use had an impact on air quality and therefore on air pollution, as well as on water pollution and water depletion (Tilman et al., 2002). These phenomena sped up the process of biodiversity loss which nowadays is considered one of the biggest issues of climate change.

To summarise, the mass scale industrialised Agro business and the changes brought by the Green revolution in the 20th century created an auto-reproducing system of profound social inequality and long-term environmental unsustainability.

Chapter 2: The Agro sector

The global business of the Agro industry

The modern expansion and revolutions of agriculture of the 20th century brought drastic changes in the earth's vegetation. By the end of the past century, a third of the planet's vegetation areas was used for crops and pasture grasses directed to human consumption (McNeill, 2000). Differently put, between 35 and 40% of the world's biological production (crops and animal culture) was used for human demand (Vitousek et al., 1986). More recent statistics show that half of the global usable land is in use for pastoral or intensive agricultural activity (Tilman et al., 2002).

Ecosystems of the earth alone, so to say prior to human modifications, provide food, fuel, fibre, raw materials, and so forth. Integral forests can drastically reduce flooding as they slow snow melting and water emission. Additionally, moderate climate, land, wild land, and forests store atmospheric carbon dioxide greenhouse gas (ibid.). Nevertheless, agricultural activity is threatening this delicate system as it reduces ecosystems' ability to provide goods. By changing composition and biodiversity equilibriums, agriculture for human consumption is worsening climate change. As this chapter will explain, the agricultural revolution and its modern form was indeed necessary to meet fast-paced increasing global food demand that followed massive global population growth in the past two centuries. Nonetheless, the way such fast modernisation happened was not explored in depth and, as a result, a huge negative impact on the environment occurred. Furthermore, despite recent research in the field being carried out, global expenditure on academic research still represents less than 2% of the total agricultural GDP worldwide (Tilman et al., 2002). This means that resources are still being channelled towards mass and intensive production, rather than on studies related to the impact this has on the environment degradation.

One of the crucial reasons that technological innovation was pursued in the field of agricultural production was the enormous increase in demand for food. This is since in the 20th century population growth trends exploded. In addition, there was a considerable

augmentation in international grain markets. Both trends massively drove wildland and forest conversion into cropland (McNeill, 2000). Irrigation and chemical fertilisers usage increased crop yields dramatically and altered the old equation between cropland and population (ibid.). In this way, the Global North was able to give net cropland expansion up, as they could increasingly push productivity of existing resources. In other terms, agricultural development after the 1960s regarded mainly, or quasi-exclusively, an effort to produce more per acre, rather than increasing the number of acres farmed.

Population increase is not a trend of the past but is deemed to persist in the near future as well. It is estimated that by 2050, the global population will be 50% larger than the current one. At the same time, global demand for grain is projected to double (Cassman, 1999). It follows that contemporary population growth trends must be matched by further increase in agricultural output which are crucial for global political and social stability and equity (Tilman et al., 2002). Having said that such an increase has an enormous and dangerous environmental impact, how can such costs be minimised while food production is increased? Answering this question requires highly complex research which data has to be embedded into policy when this is crafted. Policymakers are mostly going towards sustainable farming practices. The European Union, for instance, has introduced several forms of 'green payments' which are cash transfers to farmers and firms who utilise environmental benign farming practices (OECD, 2000). This type of fund is of crucial importance in a hyper globalised market environment which continues to become more and more competitive.

It is arguable, nonetheless, that policies such as green payments are more likely to happen in wealthier countries, unions, or federations, rather than in developing ones. Just consider the example of the European Union funds. However, some voices in the academic choir argue that international policies are not only necessary in the countries that can afford them, but also in less privileged ones that are equally or more affected by agriculture and its environmental damage (Tilman et al., 2002). In short, bigger public and private investment in sustainable Agro production, technology, and human resources is needed at the international level. This is true especially in low-income countries. Lastly, it is important to underline that the globalised market system currently operating requires

reward structures that reflect its nature. Sustainable agriculture cannot be detached from real market functioning, otherwise, it will end up penalising the worse-offs and favouring the rest. Unless policy reflects the value of ecosystem services, private and public sectors will have minor or no interest in investing in sustainable agricultural methods (Tilman et al., 2002). Insufficient investment in environmental protection and sustainable yield systems will also be insufficient to meet sustainable goals. To summarise, projections on population growth continue to foresee an increasing trend. Therefore, agricultural production has to rise in order to meet demand. This requires augmentation in crops, in efficiency of nitrogen and water usage, as well as in ecological management, usage of pesticides and livestock production practices. Agroecology is a research field that needs considerable financial injections. Research will make developments in biogeochemistry and biotechnology linked to Agro industry production happen. In turn, such developments will contribute to sustainability (DrVries & Toenniessen, 2001).

The extent of agriculture's impact on climate change can easily be overlooked. In fact, the agricultural sector is to be considered a distinct contributor to climate change, as compared to predominantly fossil CO2-emitting sectors such as energy use and transport (Tilman et al, 2000). The journal Cereal Food World published a study according to which agriculture's contribution to climate change and its potential for mitigation is distinct from other sectors. This is due to the Agro sector's unique characteristics and the different ways in which it exacerbates climate change. Emissions of non-CO2 greenhouse gases, such as methane and nitrous oxide, as well as land-use change and deforestation, are some of the main ways agriculture is worsening the state of climate change. The Green Revolution and agricultural mechanisation brought about unprecedented changes to agricultural production practices, which increased productivity but also had environmental consequences. For example, agricultural mechanisation, which involved the use of tractors and other machinery to increase productivity, led to increased energy use and greenhouse gas emissions. Researchers underline that the challenges and opportunities to mitigate greenhouse gas emission from Agro production are extremely complicated and therefore necessitate a multifaceted approach (Leahy et al., 2020). One approach is a fairly intuitive one: changes in farming practices, for instance, crop rotation, cover cropping, conservation tillage and others. These strategies can reduce emissions

and improve soil health. A second practice is improving efficiency in livestock production e.g., feed and breeding management practices. The latter, again, can reduce emissions while increasing productivity (ibid.).

Employing bioenergy and renewable energy is also a means to mitigate the Agro sector emissions. For example, crop residues and organic waste can be used for biofuel production. The latter may be used as more sustainable fossil fuel alternatives (Searchinger, 2018). However, the implementation of these mitigation measures faces several challenges. For example, smallholder farmers in developing countries may lack access to the resources and technologies necessary to implement these practices (ibid.). Additionally, there may be social and economic impacts to consider, such as the impact on food prices and employment. Policy solutions that are tailored to the unique features of the Agro business are necessary to address these challenges. According to the Organisation for Economic Co-operation and Development, policy frameworks should focus on promoting sustainable agricultural practices, ensuring access to information and technology, and promoting innovation and research in the agricultural sector (OECD, 2000). To conclude, mitigating greenhouse gas emissions from agriculture requires a multifaceted approach that considers the complexity and features of the Agro sector. Only tailored crafted policy will be able to improve efficiency of livestock production, use of renewable energy sources. All these together will in turn match food demand related to population growth. The potential co-benefits of agricultural mitigation measures can include improved soil health, increased food security and a fairer redistribution of the latter, as well as restoration of biodiversity, reduction of air and water pollution.

The Geopolitics of the Agro industry

The development of the Agro industry people are familiar with nowadays, brought enormous economic advantages. For instance, American farms tripled size from 1935 to 1985 (McNeill, 2000). Farm mechanisation considerably helped Australia and Canada as well. McNeill explains that the international consequences of farm mechanisation were overall modest in the geopolitics scheme (ibid.). This is owing to the fact that such changes reflected the existing power structures. Thus, wealthy nations could flourish even

more, whereas poorer ones did not benefit from innovation, partially because of technology's unaffordability but also for market pushes. All in all, mechanisation helped countries already well positioned in the world's market, and these nations took advantage of it becoming even stronger. For instance, North America and Australia boosted production, prosperity, and inflows massively. Once again, McNeill clearly explains the effects the new Agro industry had on the world's geopolitics and economy.

> "Both in agricultural ecology and international affairs, farm mechanisation helped select the winners – among crops, pets, and nations – in the twentieth century" (McNeill, 2000).

The issue with power is both complex and crucial in a society where power lies in the hands of those who lead the global economy. Often, most prominent traders are also the ones with vast political influence. Since politics and economics are then so tightly related, the direction politics take also triggers consequences in economic terms. All in all, big stakeholders in the Agro production have an influence in the world's food trade because in them lies the power to decide when and with who to trade more effectively and at a lower cost. At the end of the 18th century, Thomas Malthus published *An Essay on the Principle of Population* and foresaw the condition of food scarcity – or better put of unfair distribution of resources – happening today. Malthus talked about a time where population growth exceeded the land's potential to supply an adequate amount of food. This would therefore result in massive starvation and death (Tietenberg et al., 2018). This vision is a self-extinction one. As a matter of fact, the condition of precarity and huge instability humans are experiencing nowadays with climate change is indeed caused by mankind themselves. The premise of capitalism and accumulation which represents the foundation of the global system has been activating and reproducing a cycle of auto sabotage. Nevertheless, the crisis to do with food shortage does not appear of a new sort. Webster and others, when arguing about the fall of the ancient Maya kingdom, explain an incredibly similar case scenario to that been experienced nowadays. The short answer for the decline of the Maya kingdom is rising population together with heavy reliance on wood for housing and transport (e.g., canoe) building. This structure was responsible for the decimation of forests which in turn caused soil erosion. The eroded soil became much less productive and eventually diminished food productivity up to the point where the community found themselves in a position of scarcity (Webster et al., 2005). The solution

at the time was war and ultimately cannibalism. This story can be seen under the perspective that there exist no automatic problem-solving response to food scarcity. Societies can firstly be the cause of the condition they find themselves into, and secondly, be unable to find solutions and actually exacerbating the situation to be faced (Tietenberg et al., 2018). This instance suggests that the premises of auto-regulation of the market may be unsuccessful, and that adequate policy making is, as a matter of facts, necessary to address issues as food scarcity.

Returning to the contemporary world, having pointed out that modern farming techniques increased the relative advantage of mainly the USA and Australia, it might be interesting to explore to what extent the Global North as a whole benefitted from these changes. In *An Environmental History of the Twentieth-Century*, McNeill sums up the discourse around land use and agriculture explaining that, by the 1990s, European, North American, Australian, and Japanese farmers, while accounting for less than 10% of the world's population, transformed radically the agroecosystems of the globe (McNeill, 2000). These countries were, and still are, the undiscussed world leading stakeholders for Agro production. Throughout this development, they used an enormous amount of fossil fuels, chemicals, and single crop techniques. Europe, North America, and Australia are three big macro areas of the Global North. These countries fostered the modern Agro-industrial revolution. They began to develop and spread labour-saving technology which made human labour obsolete and solved the issue of costly labour itself. Fertilising, pesticides, labour-saving, and crop breeding techniques drastically reduced the costs for the Agro industry (McNeill, 2000), increased its profit massively, and benefitted the Global Northern countries enormously.

While the Global North was boosting their relative advantaged in terms of Agro production, the Global South underwent a different path. After having developed technologies which increased productivity hugely, the Global Norther economies exported this model to the Global South. This happened during the Green Revolution which promised to developing countries to boost their productivity as well. In particular, such improvements were appealing to the landowners and elites. In several countries of South America, for instance, state bureaucrats together with huge landowners saw the

possibility of dramatic revenue increase opening up. The first, aware of increasing food demand caused by population growth, recognised in the Green Revolution a way to increase efficiency without risks of alternative and unexplored paths. The latter, individuated in the modern Agro industry an extremely profitable business (McNeill, 2000). Agriculture will have become more efficient and very export-oriented: a scenario to build capital. Such capital would then be used for industrial expansion also because automatic agriculture meant transferring labour from fields to factories. In addition, the exportation of the Global North Agro business promised independence from American food aid. Therefore, some countries of Southern America saw this as an opportunity to set themselves free from foreign debt and dependence. For example, ministers of Mexico happily embraced this technology package. The short-term impact was very positive. Many countries were able to maintain food production ahead of population growth (ibid.). In the medium and long term, however, the impact of agriculture modernisation and mechanisation were not as encouraging. Developing countries' overall productivity grew but independence from the Global North did not happen in reality. In fact, countries where the Green Revolution was exported still had to purchase seeds for single crop variety from the USA, as well as fertilisers and pesticides. This kept them reliant on economically stronger nations, not differently from what occurred in the past. Even if they did not need food support anymore, they were still forced to buy inputs for internarial production from the same countries. At the same time, pesticides proved to be not without risks for human health. Data from the World Health Organisation estimates that as of 1985, a million people was enduring acute poisoning, two-thirds of which were agricultural workers (WHO, 1994). In addition, the WHO reported that around 20,000 people died for pesticide poisoning in 1990 (ibid.).

The Green Revolution somehow empowered Latin America but the Global South still fell behind. In fact, while developing countries' Agro production became more efficient and relatively cheaper, the productivity increase in the Global North kept happening at a much higher rate. As a result, the Green Revolution did not narrow the Global North and South gap. In 1950, agriculture in the Global North was seven times more labour-efficient than that in developing countries. However, in 1985, so to say after the Green Revolution spread in the Global South, the discrepancy in productivity did nothing but rise. In this

year, the Global North countries agricultural productivity was 36 times more affluent than the Global Southern ones (McNeill, 2000). By the end of the century, it was clear that food independence has not been achieved through the Green Revolution. The situation for the Global South begun to deteriorate even further when these countries could not afford to purchase their own Agri products anymore. If until the end of the 1970s developing counties had been new exporters, since the beginning of the 1980s they became new importers. This change occurred because of the increasingly competitive globalised food market that saw the Global North powers able to purchase both raw materials and agricultural products at the lowest prices in the world's economy. To sum up, the geopolitical effect of modern agricultural changes improved the relative position of the Western World, while doing little for Latin America, and worsening the relative positions of Africa.

In conclusion, the transformation of farming in the 20th century, including the Green Revolution and mechanisation, marked an enormous change in agriculture and made it more complex. Such modifications enmeshed farmers in a world of distant inputs and multiple social and economic linkages. The Agro industry aimed to make nature perform to the utmost and produce maximum output while reducing family and regional autonomy. This shift increased sharply output in the short run, however, it made the sector dependent on its own perpetuation. By the end of the 1990s, without these changes, additional prime farmland would have had to be found in order to meet food demand of the world's population. The Agro-systems created by this transformation made countries obliged to rely on international stability to safeguard required flows of inputs. This change made the system of food production and politics merge tightly, so that powerful nations held supremacy over smaller ones. The world's social and political systems now rely on the perpetuation of these Agro-systems, and their potential vulnerability to disruption represents a drift towards even greater complexity and unfairness. The transformation of modern agriculture was nearly as important as the new regime in human-microbial relations in shaping the 20th century, both fundamentally affected the well-being, health, and security of life for billions of people, and both represented a drift towards greater vulnerability and complexity of the systems that underpin modern life.

This analysis has so far brought up two key features of the Agro industry: first, its characteristics of global business, second, some of the geopolitics lying behind this sector. The second point introduced the discourse on the Global South and North divide brought about by the Agro sector itself. It has been pointed out that the Green Revolution, despite its promises to the non-western world, did not do much to empower Latin America, which remained de facto dependent on the Global North even if its economic and political linkages changed compared to the past. On the other hand, wealthier countries of the Global North were able to craft trade and agricultural policy so to increase their turnout. Britain, for instance, has been a huge food importer since the dismantle of the Corn Laws in the 1840s (McNeill, 2000). Then, British yields were unproductive from the end of the 19th century to the 1940s. Afterwards, along with the developments in agricultural techniques their yields blossomed since 1942 (ibid.). Food shortage and famine during the second world war made all government, Labour and Conservative, favour agricultural subsidies. Scientific agriculture allowed the country to double and even triple their yields in less than 40 years. By 1986, Britain reached auto sufficiency for grain production (Blaxter & Robertson, 1995). The case of the United Kingdom is not a standalone one. Similar record developments occurred in several countries that are considered part of the Global North nowadays. Among these, Europe, Australia, New Zealand, and North America, not only saw their productivity increase sharply, but also disposed of the political tools to make trade policy. This allowed them to gain incomparable competitive advantage and shares of influences unthinkable for the rest of the world. During the 20th century, while the Western block was creating the Agro business, the Soviet Union missed out the opportunity to undertake a similar agricultural revolution. The USSR would have to wait until the mid-1960s to begin practices of mechanised agriculture and irrigation. Nonetheless, they did not adhere to the doctrine of genetic manipulation and nitrogen heavy usage (McNeill, 2000).

It can be argued that the creation of a hyper, complex, and profitable Agro business has been done through the policy making and trade agreements of powerful countries of the Global North. This example of rapid economic and productivity growth proves the efficacy of well implemented policy making. However, as it appears clear today, what has been done in the last century, while boosting trade and revenue, did not leave the

hearth and many of its people undamaged. The impact of agricultural mechanisation on the environment has been having incommensurable negative consequences. Put it generally, policymaking during the Agro and the Green Revolutions did not account for environmental degradation as such but focused on boosting output and capital inflows solely. Therefore, the environmental disaster such as water depletion, soil erosion, and biodiversity loss people are facing today do not come as a surprise. Notwithstanding, one could argue that Global North countries have now the responsibility to restore – at least partially – the climate conditions to make the planet inhabitable by humans. Not only with these countries falls the responsibility, but also they possibly remain those who have the financial feasibility to undertake drastic climate policy.

The question to be addressed is how society can continue to increase Agro produce to meet population growth and their food demand while preserving the quality of ecosystems, that of land, of water and so forth. Since in a global economy the drive for change seems to be brought by profit, appropriate incentives are needed. These include sustainability benefits, ecosystem services, land management, accounting for food production environmental costs, increasing multi-nutrient-use efficiency, but also disease control and increase in water-usage efficiency. Sustainable livestock production for instance, is a crucial and effective way to reduce the environmental impact of the Agro sector. What makes a necessary *Sustainable Revolution* harder is the fact that improvements of this kind require rapidly expanding biological and agronomic knowledge (Tilman et al., 2002). Furthermore, such expertise become even harder to acquire because of the nature of knowledge being almost always very specific to the region, the agroecosystem and the soil types of the area considered. In this way it becomes complex not only to craft tailored policy, but also to spread different information across regions of the world. All in all, making fair and sustainable agricultural choices has becoming increasingly knowledge-intensive. Some timid attempts have been advanced by the Global North countries, nonetheless, it would be incorrect to call these drastic or decisive. For examples, the European Union together with Norway, Switzerland, Japan, and the United States used the Organisation for Economic Co-operation and Development's fund to institute a system of "green payments". The system envisage to reward Agro producers when they adopt sustainable benign farming strategies (Tilman et

al., 2002). Some soft green payments are the Norwegian and Swiss ones where these states provided substantial payments for "landscape maintenance". Other examples are the American green payments by the Conservation Reserve Program that pay farmers to stop production in some lands for specific time periods (ibid.). It can be argued that such strategies are soft in so far as they maintain a general purpose and leave room for interpretation and application strategies as a result. On the other hand, other hard green payments are those policy options that include taxation, subsidies removal, and regulations. These target unsustainable practices by discouraging them directly. For instance, heavily taxing fertilisers is an effective manner to reduce excessive usage. Moreover, international policies are needed too, however, the have proven to be lacking enforcement strategies since they often miss out on binding effects. The Kyoto Protocol of 1997 showed huge difficulties in attainment and enforcement of policies to reduce greenhouse gas emissions in the signatories countries. Yet, in order to address pollution and environmental degradation in a country which is actually provoked by a third country, international agreements are to be prioritised as solutions for compensation. Lastly, consumer incentives are something to be explored as well. Providing buyers with cheaper alternatives that are also more sustainable could be a key element in reducing climate change. In terms of consumer consumption, livestock products are by far the highest polluters among all others. Nevertheless, consumption of those is projected to increase in the coming 50 years (Tilman et al., 2002). Such trend can only be discouraged if consumers are offered cheaper alternatives and if information is shared responsibly and openly through labelling and pricing strategies. Labelling each product with the total environmental costs it has on the planet can be a way forward to inform and prevent. However, this is not to be considered enough alone. In fact, labelling has to be matched with pricing that also has to better reflect the *true* cost of what is being bought. Despite environmental impacts are extremely difficult to quantify, providing the right incentives firstly to producers but also to consumers can maximise the total return of the agricultural net benefits to society.

To conclude, the Agro sector, a global high-profit business, has to encounter similar high-profit oriented policy if it stands a chance to be changed into a more sustainable one. Therefore, greater public and private investment in technology and research are needed

internationally as well as regionally. Funds have to be injected especially in the Global South, where agricultural systems are far from being sustainable and efficient. For the time being, incentives for the private sector are scarce. Investment in sustainable development countries of the Global South are extremely limited as well.

> "Unless reward structures also reflect the value of ecosystem services, there will be little incentive for the private sector to invest in sustainable agricultural methods. Without adequate investments, yield gains and environmental protection may be insufficient for a transition to sustainable agriculture" (Tilman et al., 2002).

Chapter 3: Data Analysis and Interpretation

Agricultural emissions per country worldwide & Agricultural impact on climate change in Mexico, Brazil, Netherlands, and United Kingdom.

The following section aims at gathering statistical data on the impact of the Agro industry on climate change in different countries of the world. To comprehend who, how much, and where the climate disruption occurs, it might be useful to define the geographical dimension of the analysis. For this reason, this data analysis focuses on emissions per country. However, due to the existence of a hyper complex international globalised system, the choice to refer to the *state-nation* entity might be regarded as outdated. In fact, some argue that the best way to examine climate change is by looking at macro areas instead (Yla-Anttila et al., 2018). Nonetheless, there are two main reasons to choose a national-based perspective for this research. First, looking at single states is a practical way to put the analysis into the socio-historical context and to make comparisons among states themselves. Additionally, this approach allow governments to give advice and share experiences on policymaking within the supranational realm. Second, the nature of this research is analysing the international political and economic interactions between some states of the Global South and some of the Global North. For this reason, and in order to underline structural differences between these macro areas, it might be helpful to narrow data gathering to state-nations and chose this methodology. Moreover, this research aims at providing some solutions for policymaking which verts on national state initiatives, even when they operate in an international realm. Contrarily, was this to be a biology, environmental science, or food production technology research, the data analysis could have probably looked global macro areas, instead of countries alone. Nevertheless, due to the political-economic focus of the study, it is preferable to opt for the classic international approach. It is worth considering that, despite the decline of the state-nation concept, when it comes to regulations and their enforcement, national governments are still the only actors capable of enforcing the law. In fact, historically, it has been demonstrated that regulatory frameworks at the international often lack binding power.

The analysed data ranks the best and worst performing countries worldwide in terms of impact on climate change due to agricultural production. The data was collected during the last ten years. The purpose of this data analysis is understanding the impact of the

Agro sector in its complexity. For this reason, the data gathering process is split into two sections. The first section will examine Agro production and its implication on the environment of the single country. The second, will consider Agro produce distribution to and from the state, albeit import-export. Specifically, when looking at the environmental impact of Agro produce, the focus will be on four categories: impact of agriculture, effects on biodiversity, water resources, depletion, and stress, and finally climate policy. Two Global Southern countries will be compared to two Global Northern countries. The comparison will touch all the four components aforementioned. More details on the methodological analysis will be included in each section. The second part of the analysis will be characterised by an economic-oriented approach. The aim is to analyse the impact on climate change of the distribution processes of the Agro industry. To simplify such analysis and to compare the two countries of the Global South with those of the Global North, import-exports are going to be used as indicator of a country's indirect and direct impact on climate disruption through the Agro sector. Data availability varies across the production and distribution areas. Generally, production data on agricultural impact on climate change is very accessible, diverse, and straightforward. Less so is true for distribution analysis. The rationale behind this analysis is that of grasping the *indirect* impact a country might have on climate change because of its economic activity in the Agro sector. The underlying research question is whether a country that nationally performs well in terms of sustainability might have a negative impact on other countries/areas of the world.

First part: data on agricultural emissions per country worldwide

The following graph shows the countries with the biggest agricultural impact on climate change worldwide in 2020. The estimation is calculated considering carbon dioxide equivalent. Carbon dioxide equivalent (CO2e) is a measure that is used to express the total greenhouse gases amount (GHGs) emitted as a result of a specific human activity. Such activity is then express in carbon dioxide or CO2 that would have the same warming effect. This is useful is two ways: first, to understand the impact of each activity alone, and second, to facilitate a comparison once different greenhouse gases are being converted into a common unit. For instance, several greenhouse gases can be converted

into CO2e values. Namely, methane (CH4), nitrous oxide (N20), hydrofluorocarbons (HFCs) and so on.

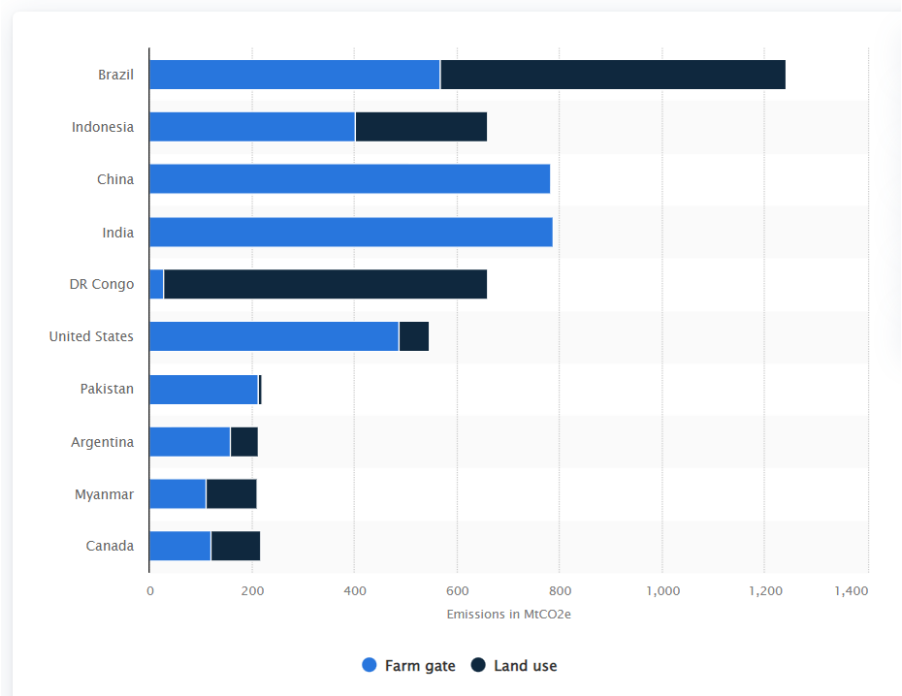


Figure 8: *Countries with the largest agricultural emissions worldwide in 2020, by component (in million metric tons of carbon dioxide equivalent)*
Source: Ian, T. (2023). Countries with the largest agricultural emissions worldwide in 2020, by component. STATISTA.

Looking at this graph, Brazil is – strikingly and by far – the country that has the biggest impact on climate change due to agricultural activity in 2020 (Ian, 2023). Its emissions in MtCO2 surpass 1.200 million metric tons of carbon dioxide equivalent. In addition, it is possible to notice that this country's CO2e emissions are roughly split in two. On the one hand, farm gate is responsible for the greenhouse gases emission, on the other, land use is causing a noticeable environmental impact as well.

For the purpose of this research and for a better understanding of the impact of agriculture on climate change, it might be useful to dwell on the distinction between environmental impact caused by land use and that provoked by farm gate. So far, this distinction might have been somewhat being dealt with superficially, or better, without sufficient clearance from a definitional point of view. Land use and farm gate are, so to say, two sides of the same coin. They both are significant contributors to climate change, and they can have similar as well as distinct impacts. To be precise, a further distinction will be made, and

three definitions will be provided. First, land use, second, agriculture per se, and third, the concept of "farm gate" will be explained.

Firstly, land use refers to the effects of human activities on the use and management of land. Deforestation, urbanisation, and conversion of natural ecosystems to cropland or pasture are three of the most recurrent examples of human activities contributing to climate disruption. This is so because such practices release important amounts of greenhouse gases into the atmosphere, in particular, carbon dioxide (CO2), for instance from the burning of forests.

Secondly, the impact of agriculture on climate change refers to the emissions of GHGs resulting from various agricultural activities which include livestock production, usage of fertilisers, tillage practices and others. Livestock, in particular, emits – through enteric fermentation and manure management – an enormous amount of methane (CH4). Fertilisers use causes nitrous oxide (N20) release, and tillage practices release CO2 from the soil. Moreover, the use of energy-intensive practices such as irrigation and heating or cooling of livestock housing contributes to CO2 and GHGs emissions.

Thirdly, the terms "farm gate" indicates the moment when Agri produces leave the farm for further processing and then distribution. It goes without saying, that if one aims at understanding the impact of the Agro industry on climate change, farm gate ought not to be neglected. Specifically, the impact of farm gate on climate change refers to the emissions of greenhouse gases resulting from agricultural activities such as crop production, livestock production, and energy use. In addition to the emissions caused by crop and livestock production, the use of heavy machinery and fossil fuels in the process (planting, harvesting, transporting, etc.) can result in CO2 and GHGs emissions. Farm gate impact can also extend to other environmental practices causing disrupting impacts on the climate. Water usage, water depletion in turn, and soil degradation, as well as ecosystem loss are some examples. Another instance is intensive irrigation practices that can lead to groundwater resources' depletion, and soil salinisation, effects which, once again, threaten ecosystems and human livelihoods. In short, the impact of farm gate on climate change is considerably important to understand the environmental impact of

agricultural activities. For the time being sustainable agriculture practices appear to be very distant from the production processes destined to human consumption, this is true in particular for large scale production. Nonetheless, sustainable agriculture ought to be considered as it has an enormous potential in contributing to reducing emissions and promoting more resilient, as well as socially and environmentally sustainable, practices for food production.

Land use, agriculture, and farm gate all have significant impacts on climate change; however, they might differ in their specific contributions. Land use is often associated with large-scale emissions resulting from activities such as deforestation. Agricultural emissions tend to be more localised and result from fertilisers' use activities and livestock management. Finally, farm gate indicates what goes beyond the traditional understanding of agriculture and touches upon the complexity of the Agro sector by looking at processing and distribution. Nevertheless, to fully grasp the impact of the Agro industry it is useful to combine the effects of all three categories. For instance, it is helpful to consider both land use changes and farm gate emissions together. In fact, agricultural expansion often leads to land use changes that can exacerbate the impact of agricultural emissions. Equally, land management practices e.g., reforestation, can contribute to mitigate the impact of agriculture emissions by sequestering carbon from the atmosphere. To summarise, the three aspects of the Agro industry that have been defined in these paragraphs are significant contributors to climate change. While they have separated effects they are also closely linked to one another. Considering the three together is useful to gain a comprehensive understanding of the agricultural impact on climate change. Moreover, keeping an eye on the distinct impacts the Agro industry has on the environment might facilitate crafting of tailored policy packages to contrast climate disruption. Opportunities for sustainable agriculture that minimise negative impacts on the environment are the possible to envisage, as well as being a necessity to combat climate change.

Returning to the analysis of the graph showing the countries with the biggest impact on climate change resulting from agriculture activity, it might be insightful to focus on the discrepancy Global South and North by looking at one country per macro area. As

previously introduced in this research, two countries of Southern America and two countries of Central European area will be analysed expansively. Whereas, Brazil, appears in the graph, none of the European area countries are part of the top agricultural produce polluters. Later in this thesis the actual role of European countries as central actors in exacerbating climate change through Agro production will be investigated. For now, however, the United States will be taken to represent the Global North. Additionally, the comparison between USA and Brazil might be telling as their country sizes are not too dissimilar. Differently, for example to the comparison between Brazil and The Netherlands. The United States is approximately 9.833.517 square kilometres, while Brazil is 8.515.770 square kilometres circa (The World Bank, 2020). Recalling the graph, emissions due to agriculture in 2020 in the USA were roughly half the size of those registered in Brazil. One might argue that there appear to be an imbalance, especially because the United States exceeds Brazil for annual food production worldwide. According to the FAO, the USA produced 671.8 million tonnes of food in 2020, while Brazil produced 603.8 million tonnes (FAO, 2021). Therefore, the Agro business as a whole, despite data shows that Brazil's agricultural activity is twice as polluting as the Northern American one, might have a bigger impact on climate change in the US. Furthermore, according to the FAO Food Balance Sheets, food consumption is by far – and perhaps unsurprisingly – higher in countries of the Global North. Specifically, FAO considered a total of 172 countries and ranked their consumption index from the highest to the lowest. While the United States is the second world consumer per average daily kilocalories intake per capita, Brazil does not appear among the first 15 country per average daily kcal intake, despite being an important world producer (FAO, 2003). So where does the responsibility for food production lie? Who is to be *blamed*, the producer or the consumer, albeit the importer? Moreover, is the global Agro business embedded in an auto-reproducing dynamic of relative disadvantage for the Global South countries compared to the Global North ones? These questions will be addressed in the following paragraphs.

Looking at relatively less recent data, it is possible to isolate countries non-CO2 emissions and so consider crops and livestock on one side, and agricultural land use on the other. The positive aspect of this data is that it was collected in a relatedly extended time span.

The graph below (Conchedda & Tubiello, 2020) shows that in terms of crops and livestock impact on climate change, the most polluting countries are India, China, and Brazil. The United States is the only country of the Global North among the top five countries for crops and livestock impact on climate change. Regarding agricultural land use, Indonesia, Brazil, and the Democratic Republic of Congo are – by far – the top three countries for non-CO2 emissions from agricultural activities. In comparison to the crops and livestock category, among the top five countries for emissions due to agricultural land use, one only county, namely Canada, is a Global Northern one. Overall, when combining the two categories (crops and livestock and agricultural land use) and looking at the biggest world's polluters, countries of the Global North are hardly included. Most countries present in this analysis are either Asian, African, or Southern American.

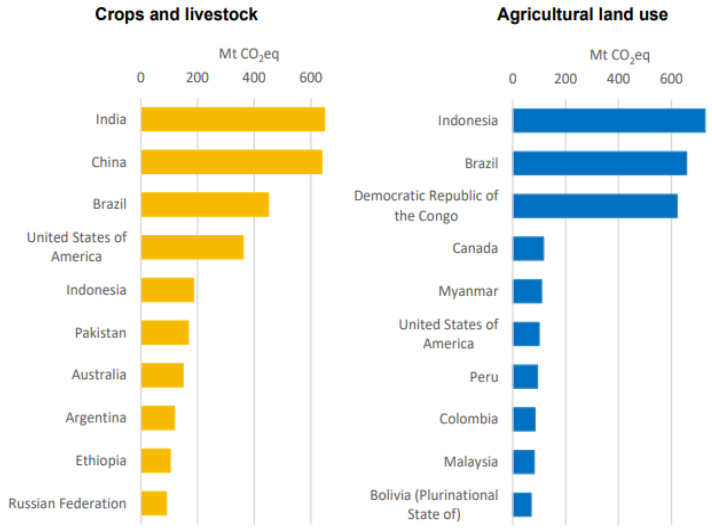


Figure 9: *Top ten countries by non-CO2 emissions from crop and livestock activities within the farm gate (left) and from agriculture-related land use (right), 2018*
Source: Conchedda, G., & Tubiello, F. N. (2020). Emissions due to agriculture. Global, regional, and country trends 2000-2018.

In the following graph (Conchedda & Tubiello, 2020), the categories of crop and livestock, and that of agricultural land use are combined. This provides a bigger picture of the impact of the Agro industry on climate change. A striking figure is that circa 30% of the total agricultural emissions worldwide are caused by three countries combined: Brazil, Indonesia, and India. These top three agricultural polluters are part of the Global South. Once again, it is possible to notice that, out of ten countries just two of them are Global Northern. Furthermore, it might be interesting to observe that Brazil and Indonesia, first two on the graph, are considerably more polluting than others. In addition,

India, Democratic Republic of Congo, and China, are also relatively much more polluting than the rest of the world countries.

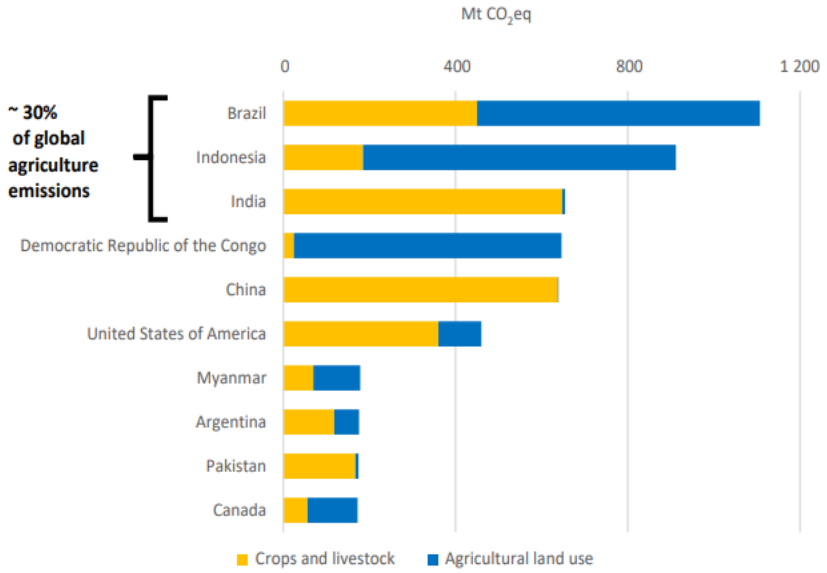


Figure 10: *Top ten countries by total agriculture emissions and relative role of crops and livestock activities and agricultural land use, 2018*
Source: Conchedda, G., & Tubiello, F. N. (2020). Emissions due to agriculture. Global, regional, and country trends 2000-2018.

The data analysed so far shows that the Agro sector in the Global South is much more polluting than in the Global North. This holds both in terms of land and agricultural use and of crops and livestock activities. Moreover, this pattern appears to be valid in terms of CO2 as well as non-CO2 emissions. All in all, Global Southern countries are the most polluting in terms of agricultural activity; this data is confirmed in the Environmental Performance Index (EPI). In the table below it is possible to look at the EPI world of 2022 which will be the focus of the next paragraph.

Environmental performance index world 2022

RANK	COUNTRY	SCORE	REG
1	Denmark	77.9	1
2	United Kingdom	77.7	2
3	Finland	76.5	3
4	Malta	75.2	4
5	Sweden	72.7	5
6	Luxembourg	72.3	6
7	Slovenia	67.3	1
8	Austria	66.5	7
9	Switzerland	65.9	8
10	Iceland	62.8	9
11	Netherlands	62.6	10
12	France	62.5	11
13	Germany	62.4	12
14	Estonia	61.4	2
15	Latvia	61.1	3
16	Croatia	60.2	4
17	Australia	60.1	13
18	Slovakia	60.0	5
19	Czech Republic	59.9	6
20	Norway	59.3	14
21	Belgium	58.2	15
22	Cyprus	58.0	7
23	Italy	57.7	16
24	Ireland	57.4	17
25	Japan	57.2	1
26	New Zealand	56.7	18
27	Spain	56.6	19
28	Bahamas	56.2	1
28	Greece	56.2	8
30	Romania	56.0	9
31	Lithuania	55.9	10
32	Seychelles	55.6	1
33	Hungary	55.1	11
34	North Macedonia	54.3	12
35	Botswana	54.0	2
36	Barbados	53.2	2
36	St. Vincent and Grenadines	53.2	2
38	São Tomé and Príncipe	52.9	3
39	Antigua and Barbuda	52.4	4
39	United Arab Emirates	52.4	1
41	Bulgaria	51.9	13
42	Dominica	51.2	5
43	United States of America	51.1	20
44	Namibia	50.9	4
44	Singapore	50.9	2
46	Poland	50.6	14
47	Panama	50.5	6
48	Portugal	50.4	21
49	Belize	50.0	7
49	Canada	50.0	22
51	Gabon	49.7	5
52	Ukraine	49.6	1
53	Saint Lucia	49.4	8
54	Kiribati	49.0	3
55	Belarus	48.5	2
56	Armenia	48.3	3
57	Israel	48.2	2
58	Grenada	47.9	9
59	Trinidad and Tobago	47.8	10
60	Cuba	47.5	11
60	Djibouti	47.5	6
62	Albania	47.1	15
63	Montenegro	46.9	16
63	South Korea	46.9	4
65	Chile	46.7	12
66	Ecuador	46.5	13
67	Venezuela	46.4	14
68	Costa Rica	46.3	15
69	Zimbabwe	46.2	7
70	Suriname	45.9	16
71	Brunei Darussalam	45.7	5
72	Jamaica	45.6	17
73	Mexico	45.5	18
74	Taiwan	45.3	6
75	Central African Republic	44.9	8
75	Eswatini	44.9	8
77	Equatorial Guinea	44.8	10
77	Mauritius	44.8	10
79	Serbia	43.9	17
80	Tonga	43.8	7
81	Afghanistan	43.6	1
81	Brazil	43.6	19
81	Jordan	43.6	3
84	Moldova	42.7	4
85	Bhutan	42.5	2
85	Comoros	42.5	12
87	Colombia	42.4	20
87	Kuwait	42.4	4
89	Dominican Republic	42.2	21
90	Bahrain	42.0	5
91	Cabo Verde	41.9	13
92	Argentina	41.1	22
93	Kazakhstan	40.9	5
93	Paraguay	40.9	23
95	El Salvador	40.8	24
96	Tunisia	40.7	6
97	Malawi	40.6	14
98	Guinea-Bissau	40.2	15
99	Bolivia	40.1	25
99	Republic of Congo	40.1	16
101	Peru	39.8	26
102	Bosnia and Herzegovina	39.4	18
103	Georgia	39.1	6
104	Azerbaijan	38.6	7
105	Guyana	38.5	27
106	Zambia	38.4	17
107	Uzbekistan	38.2	8
108	Thailand	38.1	8
109	Saudi Arabia	37.9	7
110	Nicaragua	37.7	28
110	Niger	37.7	18
112	Russia	37.5	9
113	Maldives	37.4	3
113	Micronesia	37.4	9
113	Uruguay	37.4	29
116	South Africa	37.2	19
117	Tajikistan	37.1	10
118	Turkmenistan	37.0	11
119	Dem. Rep. Congo	36.9	20
119	Vanuatu	36.9	10
121	Honduras	36.5	30
122	Gambia	36.4	21
122	Samoa	36.4	11
124	Marshall Islands	36.2	12
125	Uganda	35.8	22
126	Kyrgyzstan	35.7	12
127	Burkina Faso	35.5	23
127	Egypt	35.5	8
129	Timor-Leste	35.1	13
130	Malaysia	35.0	14
130	Solomon Islands	35.0	14
132	Sri Lanka	34.7	4
133	Iran	34.5	9
134	Tanzania	34.2	24
135	Togo	34.0	25
136	Senegal	33.9	26
137	Qatar	33.0	10
138	Côte d'Ivoire	32.8	27
138	Rwanda	32.8	27
140	Sierra Leone	32.7	29
141	Lesotho	32.3	30
142	Lebanon	32.2	11
143	Ethiopia	31.8	31
144	Eritrea	31.7	32
144	Mozambique	31.7	32
146	Guinea	31.6	34
147	Fiji	31.3	16
148	Kenya	30.8	35
149	Laos	30.7	17
149	Oman	30.7	12
151	Angola	30.5	36
151	Burundi	30.5	36
153	Cameroon	30.2	38
154	Cambodia	30.1	18
155	Algeria	29.6	13
155	Benin	29.6	39
155	Mongolia	29.6	19
158	Philippines	28.9	20
159	Mali	28.5	40
160	China	28.4	21
160	Morocco	28.4	14
162	Nepal	28.3	5
162	Nigeria	28.3	41
164	Indonesia	28.2	22
165	Chad	28.1	42
165	Mauritania	28.1	42
167	Guatemala	28.0	31
167	Madagascar	28.0	44
169	Iraq	27.8	15
170	Ghana	27.7	45
171	Sudan	27.6	16
172	Turkey	26.3	17
173	Haiti	26.1	32
174	Liberia	24.9	46
175	Papua New Guinea	24.8	23
176	Pakistan	24.6	6
177	Bangladesh	23.1	7
178	Viet Nam	20.1	24
179	Myanmar	19.4	25
180	India	18.9	8

Asia-Pacific
Eastern Europe
Former Soviet States
Global West
Greater Middle East
Latin America & Caribbean
Southern Asia
Sub-Saharan Africa

Figure 11: *Environmental performance index (EPI) world, 2022*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

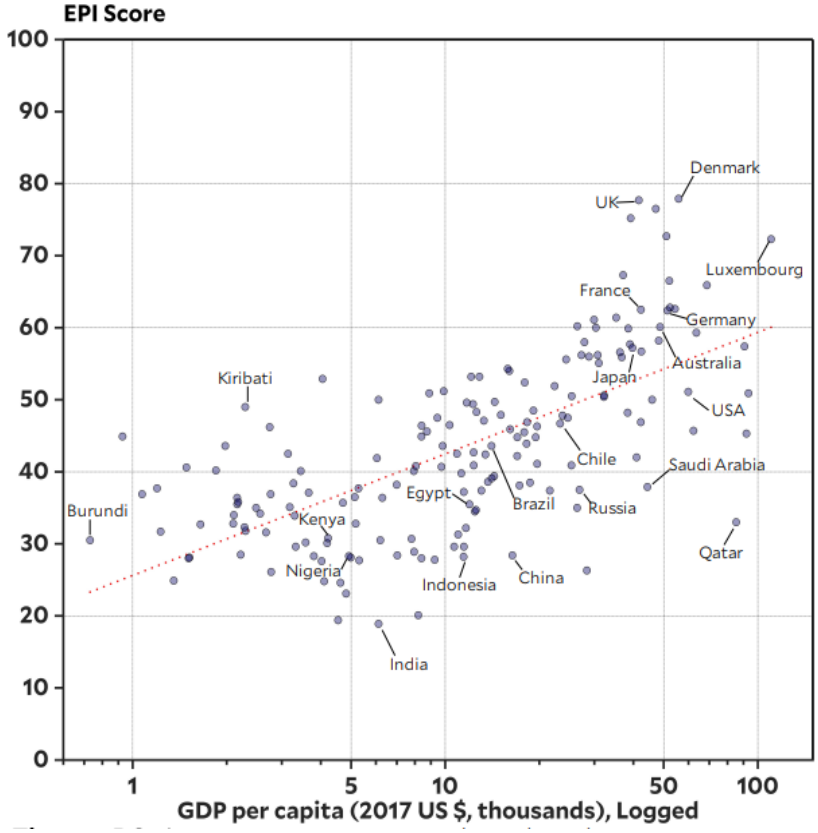
The Environmental Performance Index is a biennial report ranking countries based on their environmental performance and policies. The Environmental Performance Index for 2022 is shown in the table above (Wolf et al., 2022). The study provides data-driven

summaries per state sustainability which can be a useful tool for policy crafting. EPI indicators gather trends, effective policy practices, as well as spotting issues, outcomes, and setting targets. The EPI's evaluation uses forty performance indicators, and it is divided into eleven categories including agriculture, water, climate policy, biodiversity, and others. Unlike transnational and macro areas data analysis, the EPI focuses on each country alone. As a result, this performance index becomes a straightforward policy tool that can be used by government, committees, and commissioners of the states to improve their policy. However, it can be argued that a global phenomenon alike global change, ought to be regarded as a matter of collective global interest. As such, common transnational policy would be the best solution to address effectively the issue and to act at the root of it. Nevertheless, despite international and transnational efforts are necessary, their implementation de facto might often encounter administrative issues and political resistance. On the contrary, policy at the state level might be easier to implement and monitor for national governments that enjoy full power of law in their borders. Yet, it ought to be highlighted that political resistance continues to be a major issue in climate policy implementation, even at the national and regional level.

For the purpose of this research, four categories have been selected and analysed across four countries: Brazil, Mexico, The United Kingdom, and The Netherlands. Before digging into each country's specifics, a littler overlook of the general EPI can be made. Looking at the table above, Global Western countries dominate the top thirty positions. These countries – among which the Netherlands, the U.K., Italy, New Zealand, Finland, Belgium, and others – are in dark red, and they are part of the Global North. It should be stressed that the Global North includes other categories in this table, namely, Eastern Europe (orange in the table) and the Former Soviet States (dark green in the table). After the first thirty countries, the rest are part of the other five world macro areas, and they are countries of the Global South. These are Asia-Pacific, Greater Middle East, Latin America & Caribbean, Southern Asia, and Sub-Saharan Africa. Up until the 24th position only Global West or Eastern European countries appear. Moreover, it is possible to observe that countries of Latin America & Caribbean are spread, on average, in the central part of the overall ranking. For instance, Bahamas is 28th and bigger size countries of the region appear to be between the 80th and 113th positions. In particular, it is possible to

observe Brazil's 81st place, Colombia's 87th, and Argentina's 92nd. The worst ranking countries are mainly Southern Asian and Sub-Saharan African.

The research by the Yale Centre for Environmental Law & Policy adds another graph (Wolf et al., 2022) to the EPI table which correlates GDP per capita and EPI score.



The research indicates that EPI scores are correlated with country wealth; nonetheless, some countries lag their economic peers while other might even outperform them.

Figure 12: *GDP per capita and EPI score*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

For example, The Global Northern federation of the United States, placed 20th out of 22 wealthy democracies of the Global West in 2022. This country's position was 43rd overall. As a matter of facts, the country withdrew from the Paris Climate Agreement as well as mitigated methane emissions rules during Donald Trump's administration (Ward & Bowen, 2020). Another example of high GDP per capita which is lagging behind compared to its peers is Qatar. On the other hand, among the best performing countries of 2022, namely Denmark, the U.K., and Finland, it is possible to notice similarly wealthy countries that did not do just as well. For instance, Luxemburg, despite having a higher GDP pro capita than Denmark, performed worse in the EPI. Furthermore, Germany,

Australia, and France that have a similar position in terms of GDP per capita, did not rank as well as the U.K. for environmental action. Having pointed this information out, it might be fair to assume that a country's wealth undoubtedly plays an important role in its climate action at the national level. Nevertheless, political directions also hugely influence sustainable choices.

Second part: statistics on agricultural impact on climate change in the countries of Brazil, Mexico, the Netherlands, and the United Kingdom

The second part of the analysis of the Environmental Performance Index focuses on two countries of the Global South and two of the Global North, namely Brazil and Mexico, the Netherlands, and the United Kingdom. The aim is to provide a gist of the impact on climate change brought by the Agro sector in each country. To this end, four categories that are particularly effected by the Agro industry were selected among a total of eleven categories the EPI report analyses. These are Agriculture, Biodiversity, Water, and Climate Policy. Within each category there is a further division showing the issue more specifically. Both Agriculture, Biodiversity, and Water fall under the macro section of Ecosystem Vitality which comprises several sub sections e.g., Marine Protected Areas, Fish Stock Status, Wetland Loss, SO2 growth rate and many more. On the other hand, Climate Policy is an independent category itself. In this data analysis the overall Climate Policy performance was considered to describe each country's status. Nevertheless, it might be useful to stress that many more subcategories such as CO2 growth rate, Black carbon growth rate, or GHG intensity trend, fall under Climate Policy. Therefore, it is important not to neglect that the "Climate Policy" label comprises a wide spectrum of factors.

Whereas Brazil and Mexico are part of the South America & Caribbean region, the United Kingdom and the Netherlands are so-called Global West countries. The reason that lies behind the choice of selecting these countries for the purpose of this analysis is based on an effort to depict the difference between Global South

and Global North in terms of Agro industry impact on climate change. Needless to say, Brazil and Mexico are located in the Global South whereas the Netherlands and the U.K. in The Global North. For this research paper, four summary tables have been created. They only include the four categories considered of key importance for this specific analysis.

Brazil

Brazil

Region	Latin America & Caribbean
GDP	2989.43 [PPP 2011$ billions]
GDP per capita	14063.98 [$]
Population	212.56 [millions]
Land Area	8552004.80 [sq. km]

Country Scorecard

COMPONENT	RANK	EPI SCORE	10-YEAR CHANGE
FILTER: ALL CATEGORIES			
EPI	81	43.60	5.40
Agriculture			
Pesticide	42	48.00	NA
N Mgmt Index	17	65.00	1.20
Biodiversity	35	78.20	22.50
Terrestrial biomes (natl)	75	87.30	1.00
Terrestrial biomes (global)	93	80.00	0.60
Marine protected areas	1	100.00	90.00
Protected Areas Rep. Ind.	44	51.70	20.00
Biodiversity Habitat Index	45	54.20	NA
Species Protection Index	51	70.30	3.70
Species Habitat Index	142	45.80	-33.80
Water Resources			
Wastewater treatment	39	52.40	NA
Climate Policy	133	29.60	2.60

From this table (Wolf et al., 2022), it is possible to observe Brazil's EPI position in 2022. The country is at the 81st place out of 180 countries of the world. Concerning agriculture, the country scored 42 for Pesticide use and 17 for N Mgmt Index. On average these two agricultural subcategories score 29.5 combined. In terms of biodiversity, Brazil scored 35. However, when looking at this category broken down it is possible to spot very low performances in several subcategories, in particular for Terrestrial biomes (both national and global) and in Species Habitat Index. When considering Water resources, the country scored 39.

Figure 13: *Brazil EPI score 2022*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

Lastly, in what concerns Climate Policy as a whole, Brazil is positioned 133rd globally. The worst performing subcategories in Climate Policy appear to be Climate Change, N2O growth rate, Proj. GHG Emissions, CO2 from land cover, GHG intensity trend, and finally GHG per capita (Wolf et al., 2022). In conclusion, the worst two categories out of the four considered for this analysis are Climate Policy and Biodiversity.

Mexico

This table (Wolf et al., 2022) shows that Mexico performed slightly better than Brazil and was positioned in 73rd place according to the EPI 2022.

Agriculture wise, the country scored 29 for Pesticide use and 90 for N Mgmt Index. The average of the two agricultural subcategories combined is 59.5, with a noticeably high N Mgmt Index. Concerning biodiversity, Mexico scored 57. Very poor performances were registered in the subcategories of Protected Areas, Species protection Index, and Species Habitat Index.

Water resources of the country scored 56. Furthermore, for its Climate Policy Mexico is positioned 95th globally, showing a better performance than Brazil.

Mexico

Region	Latin America & Caribbean
GDP	2306.32 [PPP 2011$ billions]
GDP per capita	17887.75 [$]
Population	128.93 [millions]
Land Area	1960837.92 [sq. km]

Country Scorecard

COMPONENT	RANK	EPI SCORE	10-YEAR CHANGE
FILTER: ALL CATEGORIES			
EPI	73	45.50	12.40
Agriculture			
Pesticide	29	62.40	NA
N Mgmt Index	90	38.80	1.00
Biodiversity	57	69.80	23.40
Terrestrial biomes (natl)	87	80.50	5.40
Terrestrial biomes (global)	79	85.20	7.10
Marine protected areas	1	100.00	88.20
Protected Areas Rep. Ind.	126	19.20	11.10
Biodiversity Habitat Index	85	44.20	NA
Species Protection Index	129	30.00	2.40
Species Habitat Index	136	67.90	-25.90
Water Resources			
Wastewater treatment	56	25.20	NA
Climate Policy	95	38.90	16.70

Figure 14: *Mexico EPI score 2022*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

The worst performing subcategories in Climate Policy for Mexico are Proj. GHG Emissions and GHG per capita (Wolf et al., 2022). In short, Mexico is performing poorly in Climate Policy and not particularly well in Water Resources.

In the peer comparisons section of the EPI 2022 report, Brazil and Mexico ranked the worst countries for Environmental Performance in Latina America & Caribbean (Yale Center for Environmental Law and Policy, 2022).

United Kingdom

United Kingdom

Region	Global West
GDP	2797.98 [PPP 2011$ billions]
GDP per capita	41606.27 [$]
Population	67.25 [millions]
Land Area	243737.28 [sq. km]

Country Scorecard

COMPONENT	RANK	EPI SCORE	10-YEAR CHANGE
FILTER: ALL CATEGORIES			
EPI	2	77.70	23.00
Agriculture			
Pesticide	64	35.80	NA
N Mgmt Index	37	54.30	-7.60
Biodiversity	23	81.50	23.40
Terrestrial biomes (natl)	51	98.40	0.10
Terrestrial biomes (global)	54	97.90	NA
Marine protected areas	1	100.00	95.70
Protected Areas Rep. Ind.	40	53.10	10.00
Biodiversity Habitat Index	140	36.80	NA
Species Protection Index	125	31.80	9.50
Species Habitat Index	43	92.10	-2.00
Water Resources			
Wastewater treatment	6	99.00	NA
Climate Policy	2	91.50	47.10

This table (Wolf et al., 2022) shows that, in 2022, the United Kingdom scored extremely well for Environmental Policy Index; the country was indeed positioned 2nd out of 180 world countries analysed. Denmark was the only country performing better than the U.K. Concerning agriculture, the country scored 64 for Pesticide use and 37 for N Mgmt Index. These two agricultural subcategories combined scored 50.5.

Figure 15: *United Kingdom EPI score 2022*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

In terms of biodiversity, the United Kingdom scored 23 overall. This country has however done particularly bad in the Biodiversity Habitat Index and registered quite a low performances in Special Protection Index too.

In terms of Water Resources, the country scored 6. Lastly, the U.K. scored particularly high in Climate Policy as a whole acquiring the 2nd position globally. Within this category, the country placed 1st for Black Carbon Growth rate and for Proj. GHG Emissions (Wolf et al., 2022). The United Kingdom did well in Climate Change Policy and CO2 growth rate, scoring 2nd worldwide. Notwithstanding, the United Kingdom has lagged behind in some subcategories of Biodiversity. Additionally, despite the brilliant result in Climate Policy as a whole, the United Kingdom scored 119th for GHG per capita.

Netherlands

The Netherlands was 11th in the 2022 Environmental Performance Index. This table (Wolf et al., 2022) considers Agriculture, Biodiversity, Water Resources, and Climate Policy. The data results across these four categories appear mixed. The Netherlands scored 120 for Pesticide use and 80 for N Mgmt Index, which, combined, represent an average of 46.

Looking at Biodiversity, the country scored 31 overall. Nevertheless, the Netherlands did very bad in Biodiversity habitat Index. Negative figures were also registered for Species Habitat Index and for Species Protection Index.

Netherlands

Region	Global West
GDP	947.50 [PPP 2011$ billions]
GDP per capita	54325.51 [$]
Population	17.44 [millions]
Land Area	37810.95 [sq. km]

Country Scorecard

COMPONENT	RANK	EPI SCORE	10-YEAR CHANGE
FILTER: ALL CATEGORIES			
EPI	11	62.60	5.90
Agriculture			
Pesticide	120	18.70	NA
N Mgmt Index	80	40.00	-3.00
Biodiversity	31	80.10	6.60
Terrestrial biomes (natl)	43	99.80	9.80
Terrestrial biomes (global)	67	93.50	8.60
Marine protected areas	1	100.00	NA
Protected Areas Rep. Ind.	52	47.40	14.80
Biodiversity Habitat Index	171	30.20	NA
Species Protection Index	95	44.20	7.30
Species Habitat Index	109	78.20	-2.20
Water Resources			
Wastewater treatment	1	100.00	NA
Climate Policy	32	54.50	10.60

Figure 16: *Netherlands EPI score 2022*
Source: Wolf, M. J., Emerson, J. W., de Sherbinin, A., & Wendling, Z. A. (2022). 2022 Environmental Performance Index.

In terms of Water Resources, on the other hand, the country did extremely well and acquired the 1st EPI position out of 180 countries considered. Finally, the Netherlands scored 32nd with Climate Policy category. Within this category Black Carbon Growth rate and CH4 Growth rate improved particularly. Contrarily, N2O Growth rate worsened scoring 144th out of 180 countries. GHG per capita and Proj. GHG Emissions were not good either.

Comparing data across countries

On the one side, Brazil and Mexico are the Global South countries considered in this analysis, on the other, the Netherlands and the United Kingdom are the Global North countries taken into account. According to the EPI 2022, the first two countries did not perform as well as the second two. Nevertheless, interesting data comes up from a closer look at the subcategories considered. The table below provides a summarised overview of the four categories considered in this analysis, which aims at making cross-country comparisons more accessible.

Category / **Country**	Agriculture	Biodiversity	Water	Policy
Brazil	29.5	35	39	133
Mexico	59.5	57	56	95
United Kingdom	50.5	23	6	2
Netherlands	46	31	1	32

Beginning with Agriculture, none of the four countries examined did particularly well. Brazil, however, did better than the other three scoring 29.5. Looking specifically at the subcategory of Pesticide Use, the United Kingdom and the Netherlands' performances were poor. The first scored 64, while the second 120. On the other hand, Brazil and Mexico scored respectively 42 and 29 for the same category.

Moving to the complex category of Biodiversity, three of the countries considered scored similar, namely: Brazil, the United Kingdom, and the Netherlands. On the contrary, Mexico did worse compared to the others. The biodiversity category was broken down into seven subcategories which results will be now briefly examined. All countries excluded the United Kingdom performed badly and very badly in Species Habitat Index (Brazil: 142, Mexico: 136, U.K.: 43, Netherlands: 109). In terms of National Terrestrial Biomes, Brazil and Mexico did worse than the other two countries. Nonetheless, the U.K. and the Netherlands registered quite low scores too (Brazil: 75, Mexico: 87, U.K.: 51, Netherlands: 43). Yet, the gap between these Global Southern and Northern countries

narrows further when looking at Global Terrestrial Biomes (Brazil: 93, Mexico: 79, U.K.: 54, Netherlands: 67).

In terms of Water Resources, the gap between Brazil and Mexico on one side and United Kingdom and Netherlands on the other is striking. In fact, these last two countries performed extremely well in Wastewater Treatment and Water Resources more generally (Brazil: 39, Mexico: 56, U.K.: 6, Netherlands: 1). On the contrary, Mexico was the worst out of the four countries.

Last of all, Climate Policy scores were polarised. The two Global South countries ranked very low, respectively 133 for Brazil and 95 for Mexico. On the contrary, the two Global North ones ranked very well in this category. The United Kingdom scored extremely high and gained the 2nd position in the EPI 2022 for Climate Policy, whereas the Netherlands was positioned as 32nd. At the national level and in terms of government policy, Brazil and Mexico undoubtedly did bad. Having said this, it might be interesting to look at the GHG per capita subcategory. Among the four countries, Brazil was the only one slightly decreasing their GHG per capita compared to the previous EPI in 2020. Whereas, Mexico, the United Kingdom, and the Netherlands, increased their GHG per capita emissions. In terms of GHG per capita, out of 180 countries analysed, Brazil scored 102, Mexico 106, the United Kingdom 119, and the Netherlands 152. All four countries did not do well compared to the rest of the world. Particularly striking is the fact that two of the top scorers of the overall EPI 2022 – U.K. and Netherlands – did worse than Brazil, Mexico, and many others.

Chapter 4: The Agro business in the Global Market

The state of Agro produce import-export in each country

Having pointed out the overall and per sector environmental impact in 2022 of four countries, it may be insightful to consider the environmental impact of their import and export exchanges as well. The directorate general for agriculture and rural development of the European Commission publishes a statistical factsheet once a year where data on import and export is reported. In this paragraph a summary of the reports of Brazil, Mexico, United Kingdom, and Netherlands will be presented. The aim is grasping the *indirect* impact of the Agro sector caused by these exchanges happening in the global market: a market characterised by saturated international import-export routes. In other words, looking at the production side alone might not be sufficient to grasp the impact on climate change of the Agro business, simply because this industry operates in a context of a hyper globalised market. Therefore, the environmental impact of the Agro industry cannot be fully understood if not examined in its entirety and complexity.

When researching about Agri produce import and export, data is very often reported in terms on money value of imports and exports. Despite, apparently, leaning more towards the economics sphere than that of sustainability, grasping the economic influence of a country's Agro business in the world's market allows one to understand its political influence. This perspective might be useful in terms of total environmental impact a country has both in terms of direct and indirect effects on climate change. For example, The Netherlands, despite having a good score in terms of environmental impact as pointed out in the previous section, is one of the top exports worldwide in terms of billions of dollars per year. The Food and Agriculture Organisations of the United Nations listed the biggest exporter countries in 2019 and the Netherlands was the second largest exporter worldwide, with exports value reaching nearly 80 billion US dollars annually (FAO, 2022). Only the USA – with 118 billion US dollars – exported more than the Netherlands in 2019. Germany, France, and Brazil followed the Netherlands with respectively 70.8 US billion dollars, 68 US billion dollars, and finally 55.4 US billion dollars in the same

year (ibid.). What might be regarded as striking about the Dutch export figures compared to the USA ones, is that the Netherlands is about 237 times smaller than the United States in terms of squared kilometres. Its population – approximately 17.5 million people – is also incredibly tinier than the American one which accounts for approximately 337.5 million people.

If in the previous section the research looked at individual country performance in terms of sustainability, this section aims at gathering information concerning individual country import and export figures. These might then be looked upon in terms of their environmental impact. The global Agro business in its latest configuration is indeed characterised by food availability regardless of seasonality and area-production. In other terms, especially in countries of the Global North, a huge variety of food products is available every day and throughout the whole year, without local or seasonal discrimination of any kind. For this reason, importation and exportation are necessary and have developed incredibly over the past two centuries in order to sustain such system.

Brazil

The relation between the European Union and Brazil in terms of import and export is quite tight. The flow of Agri products traded from Brazil to the European Union (27 member states plus the U.K.) is significant. The European Union's – including the United Kingdom – imports share for total Agri-Food trade from Brazil was 10.4% in 2021 (Directorate-General for Agriculture and Rural Development, 2022). The same report indicates that the main Agri-food trade partner of Brazil in 2021 was the United Kingdom. The value of the Agri-food trade between these two countries accounted for nearly 42.000 million Euros (ibid.). On the other hand, the exports from the EU to Brazil were much lower and accounted for barely the 0.9%. It can be argued that there is an imbalance of import and export between Brazil and the European Union. As a matter of facts, the share of Agri-food export to the EU is much higher than that of import from the EU to Brazil. This data indicates that a large part of the demand for Agri production comes from the European Union.

Considering the evolution of 20 top EU Agri-Food imports from Brazil between 2017 and 2021, a steady increase in the total share for imports is noticeable. Across 20 Agri foods considered, only 5 decreased their import share between 2020 and the following year. All the other Agri-food types registered an increase of import in percentage change between 2020 and 2021 (Directorate-General for Agriculture and Rural Development, 2022). For instance, soybean production increased of 49.5% between the two years. Additionally, beet and cane sugar production increased by 56.7% and fresh and dried fruit – excluding citrus & tropical fruit – by 28.8% (ibid.). This data can be interpreted as an exponential increase in Agri-produce import from Brazil to the European Union. This trend has been observed steadily for 5 years from 2017 to 2021. The global Agri-food market, and the exchanges it generates, have the potential of destroying the environment and worsen increasingly the precarious situation humanity is currently experiencing. Since the capitalist economy works on the premise of increasing production where demand expands, it can be argued that countries that demand more Agri produce are to be blamed for the expansion of such sector and, subsequently, for their indirect effect on climate change.

Mexico

The exchanges related to Agro products between Mexico and the European Union are indicated by another annual report by the Directorate-General for Agriculture and Rural Development of the European Commission. It appears that the imbalance between imports and exports between Mexico and the EU is not as important as that between Brazil and the EU. In fact, as in 2021, the share of EU total Agri food trade with Mexico is 4.6% exports and 5.1% imports (Directorate-General for Agriculture and Rural Development, 2022). Despite this figures, the report shows a substantial increase in Agri food import from Mexico to the EU. Namely, between 2020 and 2021, imports increased by almost +14% (ibid.). In addition, a table showing the evolution of 20 top EU Agri-Food imports from Mexico in 2017-2021 indicates that all food categories, apart from three, have been steadily augmenting. Moreover, some food type imports to the EU have dramatically increased between 2020 and 2021. For instance, chocolate, confectionary and ice cream importations from Mexico increased by +250% in one year, taking the yearly value from

4 million of euro in 2020 to 14 million in 2021. Between 2020 and 2021, the percentage change in pet food imports from Mexico was +450% (ibid.). Other categories that have increased hugely since 2017 are beer, vegetables (fresh, chilled, and dried), essential oils, fresh and dried fruit, spirits and liqueurs and others.

If, on the one hand, exports from Mexico have increased in the past six years, on the other hand, the country's environmental performance index has worsened. In 2017, the Environmental Performance Index placed Mexico in 51st position worldwide (Yale Centre for Environmental Law & Policy, 2017), while in 2022 the country's position was 73rd (Wolf et al., 2022). In terms of Agri production and its influence on climate change one patter seems to hold: the more production – comprise of distribution e.g., export – the greater the environmental impact. FAO indicates that world goods and agriculture production are responsible for the worsening of the environment as they contribute to biodiversity loss, water depletion, human exploitation, energy usage and spillages and so forth (FAO, 2021). As a result, it can be argued that a higher food demand from a party e.g., EU, worsen the environmental performance of who will supply, namely the second party e.g., Brazil.

United Kingdom

According to the report by the Directorate-General for Agriculture and Rural Development of the European Commission, the United Kingdom has a huge share of both import and export in relation to the European Union in 2021. In terms of import, the U.K. was the biggest importer of Agri-food from the EU in 2021 with an estimated value of nearly 42.000 million euros (Directorate-General for Agriculture and Rural Development, 2022). In terms of exports, if Brazil was the first country to export its Agri-food to the EU, the United Kingdom, with approximately 12.000 million euros, was the second (ibid.).

Netherlands

The Netherlands, differently to the other three countries, has much more contained

import/export shares with the European Union. In addition, little data is available on the European Commission factsheet 2022.

Analysis

Looking at the analysis conducted so far, it can be argued that some countries of the Global North e.g., EU countries, benefit economically from the Agro sector international trade exchanges at the expenses of some Global South countries, at least from an economic point of view. Parallelly, an argument related to ethical concerns can be made. In fact, countries of the Global South appear predominantly at the end of international sustainability indexes, while Global North ones often score very high. At the same time, such indexes are often based on single country emissions and other paraments related to that country alone, without accounting for the indirect effects. In the Agro industry, for example, emissions caused by import and export might often be neglected. Looking once again at Brazil and its trade relations to the United Kingdom, it was found that the import to the latter from the Latin American country was elevated. Notwithstanding, when then considering the EPI 2022 index (see chapter 2), Brazil scored poorly in terms of sustainability (81st worldwide), whereases the United Kingdom scored very high (2nd worldwide). In short, there appears to be an incongruence or a neglection in terms of environmental impact between these two countries. Therefore, further analysis will attempt to identify such neglection.

The United Kingdom and the Netherlands are considered strong economic powers within the European Economic area. They both are organised around a neoliberal system. The article *"Researching climate change and community in neoliberal contexts: an emerging critical approach"* describes the political manner in which neoliberal economies deal with climate change. The same piece of literature also indicates how the communities within neoliberal countries of the Global North are backlashing the government action/inaction more and more (Aiken et al., 2017). In other words, there is a conflict within neoliberal countries. On one side, their governments are regarded as ineffective and unfair in their actions to contrast climate change, on the other, critical communities of citizens who question the government's approaches develop within the same countries.

The latter are seen as sites of contestation, tension, rebellion which depart from the political sphere and commit in community-based action to reduce their environmental impact (ibid.). Nevertheless, Global North economies continue to pursue market profit without or with minor attention to the environmental disruption this causes. The neoliberal political approach of several countries in the Global North aims at preserving and better the environmental conditions within the country, without necessarily paying attention to the impact they might have outside their borders. In the neoliberal context, governments and policymakers have been suggesting that the *community* should be the centre of climate mitigation. According to this approach, the communities should be those addressing the issue of climate change. However, recently, this view has been criticised by several scholars. Walker stands against the tendency of policymakers to attribute to the community the role of unproblematic entity that can defeat environmental problems (Aiken et al., 2017). Nevertheless, mainstream political ecology, especially in the Global South, attributes an important role to communities pursuing sustainable development. Holdcroft argued that:

> "Many leaders of developing nations and external donors viewed community development (CD) as the means to mobilise rural people as resource for and the objective of economics, social and political development" (Holdcroft, 1976) .

Such approach, after initial enthusiasm, was quickly criticised due to unclear empirical outcomes. Critics argue that CD projects might instrumentalise communities and depoliticise the goals that society must achieve (Aiken et al., 2017). Traditionally, Horkheimer called "the servant" the phenomenon according to which the researcher fails to recognise the societal structure underlying the empirical object of the study (ibid.). More recently, other studies, such as Creamer's, have pointed out that often policies pushing communities to mitigate the effect of climate change can result counterproductive, with a failure in employing communities as environmental aims (Creamer, 2015).

Conclusion and limitations of the analysis

The aim of this section was to broaden the analysis of a country's environmental impact related to the Agro sector. Specifically, the effort was to draw a bigger picture of a country's impact by including in the evaluation factors that are traditionally excluded. For example, when accounting for a country's sustainability index, evidence showed that what is measured falls within what happens in the country's borders. This is arguably anachronistic, due to the fact that each country is placed in a globalised environment and therefore does not operate in a vacuum. Therefore, it is now important to consider the indirect effects as well. For this reason, import and export exchanges were analysed. Such reading allowed this study to unveil aspects that would have otherwise gone unnoticed. In particular, it was possible to demonstrate that countries scoring very high in terms of environmental impact, might contribute to climate change indirectly; for instance, with elevate demand for import from the Global South (United Kingdom and Brazil). The case of the Netherlands was particularly interesting as it is double faced. The country registered a high demand for import from other countries of the Global South, but also an exponential export activity outwards other countries. In other words, not only this country has indirect environmental impact when it imports Agri products, but it generates even further pressure on the climate when it operates as one of the leading exporters worldwide.

Having said this, it is also crucial to underline the limitations of this analysis. Despite aiming at broadening the understating of the phenomenon at stake, there are still a number of factors that fall beyond this research's considerations. For example, much of the data considered regards greenhouse gas emissions as the parameter to measure the environmental impact of a country. It goes without saying that this limits the completeness of the analysis as it excludes other variables. In this case, it might be fair to say that the analysis conducted in this chapter is a first step and effort to attempt to include more indirect factors to the analysis of a country's environmental impact.

Chapter 5: The impact of the Agro sector on climate change in the Global South and the responsibility of the Global North.

Case studies: Water depletion in Mexico. Avocado trading between South America and the United Kingdom. The example of EU agricultural policy for a sustainable development.

Case study: Mexico

Climate change does not impact everyone equally in the world. As pointed out previously, countries of the Global North are more equipped to face environmental degradation than those of the Global South, put simply because the first are wealthier than the second. This is because wealthier countries generally dispose of better infrastructures, health care and research & innovation budgets. Yet these countries often accumulated such privileges through lucrative businesses responsible for huge emissions, exploitation, and inequality partly within the countries and more importantly outside them. On the one hand, Global North countries are responsible for a big part of global CO2 emissions and climate change broadly. On the other, Global South countries generally contribute a much lower share to global emissions but, yet, are suffering the burden of climate change the most (Patz et al., 2007). In addition, as climate change continues to worsen, extreme weather events e.g., droughts and typhoons will be more frequent and life-threatening. As a consequence, the gap between rich and poor countries will expand and the effects described above will exacerbate.

In the following chapter, two main questions will drive the analysis. The first is: what impact does the Agro sector has in the Global South? In other words, having pointed out that climate change consequences weight more heavily on countries of the Global South, what does it imply for a country such as Mexico to manage climate stress? The case study of water stress management in Mexico will be used as a case study. The second question that will be explored in this section is: where does the responsibility to contain the effects of the climate catastrophe lie? Differently put, since historically responsible for climate change, should the Global North countries compensate for the environmental damage?

To attempt an answer the countries of the Netherlands and the United Kingdom will be used as examples as they share interesting common features in terms of inner country environmental impact, global trade import/export trends and neoliberal approaches.

Mexico is a country that has historically contributed relatively little to climate change. In fact, from 1751 to 2017, it has been responsible for 1.2% of cumulative CO2 emissions (Chapman & Ahmed, 2021). As shown in the table below, North America, Asia, and Europe are the areas historically responsible for the highest cumulative CO2 emissions (Ritchie, 2019). Nevertheless, Mexico is also expected to suffer high consequences of the phenomenon; especially because Mexico's variety of regional climates makes the country vulnerable to several climate threats. A central issue for Mexico revolves around water. Because of human activity, threats such as droughts, floods, tropical storms, rising sea levels and ocean acidification, are more and more recurrent in the country's area. Looking at the cumulative CO2 emissions of the "Europe" macro area (comprising U.K., Netherlands, but also Russia), it possible to see that this responsible for 22% of the global CO2 emissions from 1751 to 2017 (Ritchie, 2019). The difference in terms environmental impact countries of the Global North and Global South have had in history it is arguably striking when looking at the visual representation below.

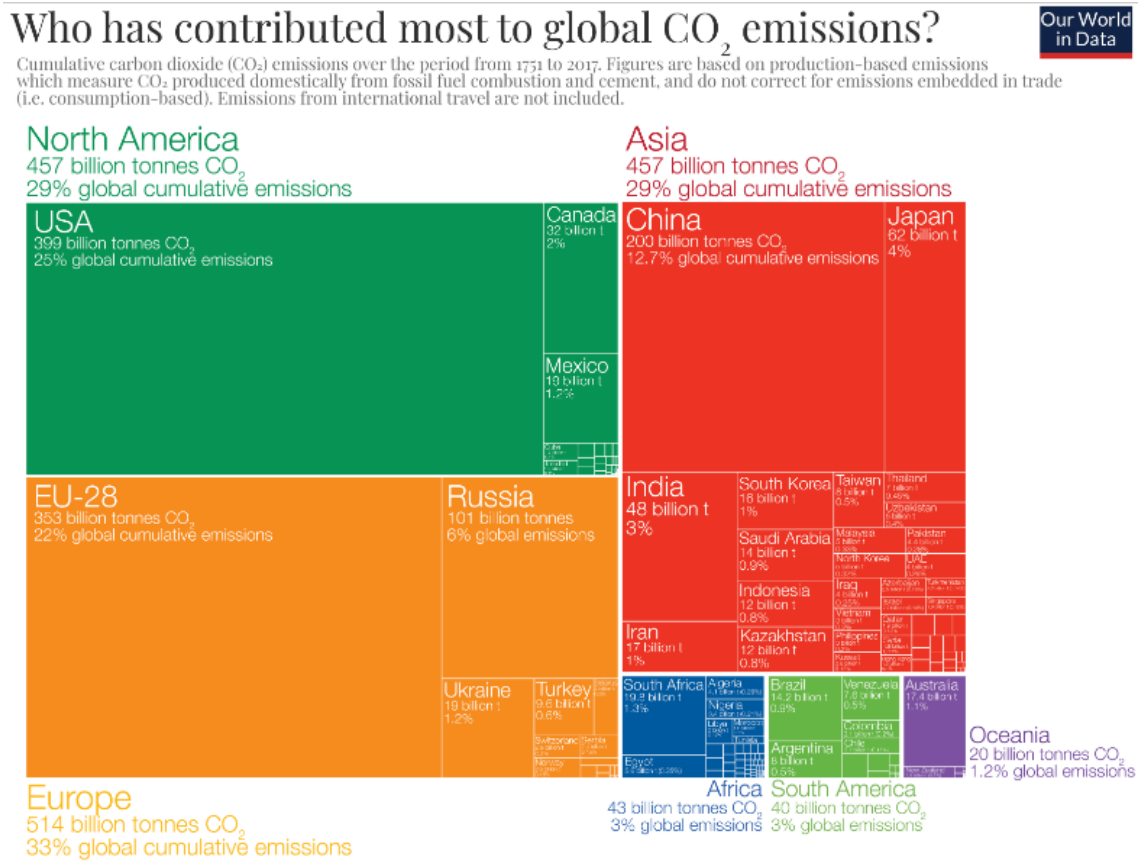


Figure 17: *Who has contributed most to global CO2 emissions?*
Source: : Ritchie, A. (2019). Our World in Data.

This first part of the chapter will investigate the phenomenon of water depletion in Mexico. In the following part, in order to explore the linkages between Mexico and the Global North, the phenomenon of virtual-water trade will be introduced. Such a phenomenon is relevant because it raises economic, ethical, and environmental concerns around resource depletion and distribution.

Water is divided into two main categories: groundwater which is beneath earth's surface, and surface water, which is any water found on earth's surface. Groundwater represents 98% of earth's available freshwater (Mullen, 2019). For agriculture and the functioning of the Agro sector has a whole, water represents a pivotal resource which is needed at all stages of production and distribution processes. Contemporary agriculture technologies are capable of utilising both types of water to their ends. Nevertheless, recently, groundwater quality has been deteriorating, and evidence points out that saline water from irrigation might be one of the crucial causes of such deterioration (Mora et al., 2022).

Surface water includes ocean and freshwater in rivers and lakes but just 3% of the world's water is freshwater. 2.5% of the world's freshwater is part of polar ice caps, atmosphere and soil which makes it not available. This implies that 0.5% of freshwater is destined to human consumption and activities among which agriculture. For this reason, water is considered a scarce resource. Monitoring surface water streams is essential to quantify the impact of human activities on climate change and water availability (Cheng et al., 2022), simply because climate change, among other effects, is causing water depletion, and the Agro sector is causing water depletion.

Researchers point out that Mexico faces several water security challenges including water scarcity, pollution, and management (Arreguin-Cortes et. al., 2020). Water depletion is among the factors contributing to water scarcity. Water depletion is a drastic reduction of the amount of usable water caused by human activity. Such activity can range from import/export to agricultural cultivation. The last instance represents a relevant issue in Mexico. The country has in fact a water-intensive agricultural production which causes soil and freshwater salinisation. Moreover, such practice increases energy consumption and costs from pumping and therefore results in a high economic impact. This process is concerning because it has broad consequences on the environment. As a matter of fact, groundwater overdraft has led to diminishing river flows; additionally, this phenomenon is impacting biodiversity because of the effect it has on animal and plant communities that depend on groundwater (Zektser et al., 2023). In Mexico, the issue of water depletion, caused by – among others – the Agro production, is most intricate because of the diverse environmental landscape. This country is particularly interesting from an environmental studies perspective as the climate change challenges vary as the landscape does. In other words, Mexico has different climates and urbanisation's levels in each region which makes it difficult to quantify the state of water depletion at the national level (Arreguin-Cortes et al. 2020). Therefore, researchers often focus on evaluation of environmental challenges at the regional level. Nonetheless, this is not the most useful analysis for the scope of this thesis. In this case, it might be interesting to explore those factors that tide the country up with other countries with the aim of grasping the impact of the Agro sector globally. In order to do so it might be useful to look at the concept of virtual-water trade. "Virtual-water" is water consumed during the production processes of agricultural and

industrial products (Hoekstra & Hung, 2002). For instance, if one thinks about the production of one tonne of grain, that will have one tonne of virtual water embedded in it (Allan, 1999). The rationale behind virtual water is explained by the amount of water that was necessary in order to raise that amount of product. On a second stage, when products are sold in foreign markets, the embedded virtual water within the goods will be exported too. In theory, water-abundant countries would produce water-intensive products. In fact, according to classic economic assumptions, virtual water in national trade would naturally be exported from wet to dry areas. Nevertheless, some researchers have proven that this is not the case and that the contrary often happens. In the following image it is possible to visualise the net virtual water import per country. The biggest importers are coloured in red, whereas the smallest in dark green.

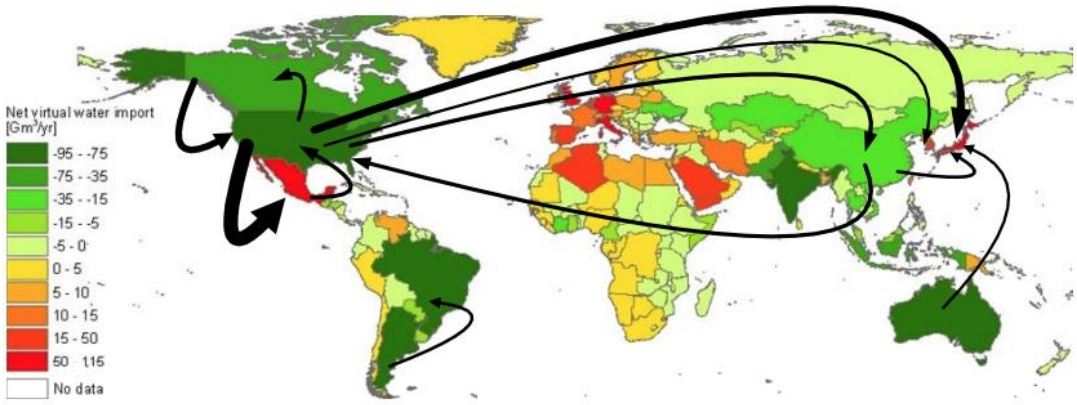


Figure 18: *Virtual water balance per country and direction of gross virtual water flows related from 1996-2005.* Source: National water footprint accounts (Mekonnen & Hoekstra, 2011).

Mexico, as noticeable in the image above, scores very high on virtual water import. Yet, the country is generally considered a water-scarce country. It follows that interesting considerations about Mexico can be drawn.

In 2019, Mexico was the 9th largest exporter and 13th largest importer worldwide. In the same year, this country was the world's biggest exporter of trucks and tractors, as well as of beer and tropical fruit (OEC World, 2020). Given Mexico's position as a huge exporter of water-intensive goods, the country could be expected to be a net virtual-water exporter. To understand if this assumption is correct, some researchers have computed the size of virtual-water trade in Mexico (Mekonnen & Hoekstra, 2011). To estimate the dimension of international virtual-water flows, the volume of trade of a certain good is multiplied by

the average water footprint of the product. Such calculations concluded that in 2011 Mexico imported a total of 92,298 Hm^3 of water and exported 26,105 Hm^3 of water (AgroDer, 2012). Therefore, Mexico is a virtual water net importer. This might come as a surprise since Mexico is an important exporter of Agri products associated with high water footprints. Nevertheless, when examining Mexico's trade flows, it is possible to understand that, overall, Mexico is relatively import-dependent. Data shows that the country has had a trade deficit between 2000 and 2019 (UNCTADstat 2020). Furthermore, it is relevant to bear in mind Mexico's position as an importer of agricultural goods, while being an exporter of others. For instance, Mexico imports huge amounts of grain from the USA, which requires 7.1 billion m^3 of water per year to grow in the neighbouring country. Grain production is much more efficient in terms of water usage in the USA compared to Mexico. In the second country growing the same quantity of grain would require 15.6 billion m^3 of water per year. Having said this, one could argue that the virtual-water trade through grains actually saves 8.5 billion m^3 of water per year (Hoekstra & Chapagain 2008). In short, despite Mexico exports virtual water through some agricultural goods, their exported virtual water is offset by the amount they import. This would confirm the classic economic theory according to which water flows from water-abundant to water-scarce countries. As a result, it might be said that, in Mexico, virtual-water trade is not contributing to water depletion, but instead to water augmentation. Nevertheless, before drawing a conclusion it is worth considering all factors impacting virtual-water trade. Simply put: is Mexico a net importer of virtual water because it is a water-scarce country, or are there other factors at play?

Despite generally classified as "water scarce country", different regions in Mexico know different climates, ranging from tropical zones to hot deserts. Therefore, a huge variety in the Global Water Security Index in Mexico per state exists are it is visible in figure 19 (Arreguin-Cortes et. al., 2020). It follows that, classifying the whole country as water-scarce already gives a false impression of its water availability. Moreover, some authors argue that there is no correlation between national water endowments and virtual-water trade patterns because other variables impacting international trade, e.g., government programmes, are excluded (Ramirez-Vallejo & Rogers 2009). In Mexico in particular, the government subsidise many crop types and regulates water prices. This results in

water prices being kept artificially low through policy. In turn, this result in an inefficient allocation of water.

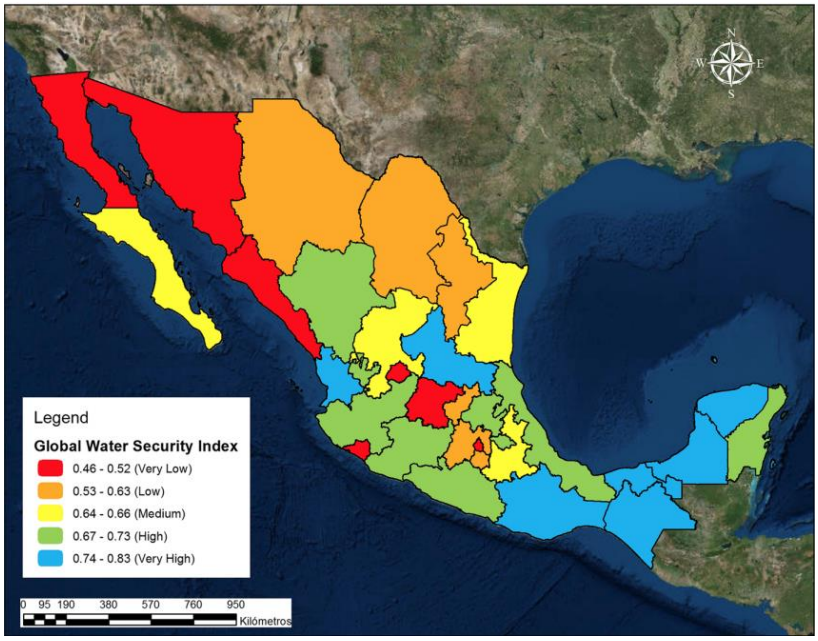


Figure 19: *Virtual water balance per country and direction of gross virtual water flows related from 1996-2005.* Source: National water footprint accounts (Mekonnen & Hoekstra, 2011).

Virtual-water trade is just one of the many factors contributing to water depletion in Mexico, but it is an interesting one to look at the relationship the country has with other world's nations. Considering that a big share of goods from Mexico are bought and sold in the global market, virtual-water trade is undoubtedly a big contributor to water depletion; at least in water-scarce areas in Mexico. Therefore, it can be argued that the country is not to be held accountable alone for this issue but that a wider range of stakeholders are involved. As pointed out in Chapter 3, Global North countries such as the Netherland and the United Kingdom, are conspicuous importer of Mexican Agri-produce. However, one could argue that blaming wealthier countries would imply neglecting poor local policy and governance. Many scholars attribute inefficiency of local government policy as the leading factor determining the direction of the virtual-water flows. Contrarily, if there was a better water management, the efficiency of water allocation would better. In turn, this would minimise water depletion in water-scarce areas. To respond to such claim, it is necessary to consider several ethical concerns that virtual water trade brings to the forth. First of all, the phenomenon of water trade is increasingly regulated by neoliberal governments together with multinational

corporations. Factually, such system has provoked and is provoking dangerous outcomes in terms of distribution and redistributions of profit and goods. Put simply, very few – if not any – huge profit-oriented businesses around the world see fair treatment of people and environment at the hearth of their work. Often from the Global North, big private and public stakeholders neglect fair treatment of less wealthy countries namely those of the Global South. This is the case when it comes to the Agro sector too. Regarding water in particular, intensive agriculture is characterised by over-exploitation of resources which causes both groundwater and surface pollution. In this context, poorer local communities tend to be affected disproportionately by large scale Agri-production businesses disproportionally (Boelens, Perreault & Vos, 2018). This happens in countries such as Mexico. Moreover, this system has created a scenario where Global South countries are increasingly dependent on import of water from wealthier countries. As a result, these countries are more and more tightly dependent from the Global North, and this does not allow them to stop those processes that are detrimental for the environment. Some scholars explain that being a high water import dependent economy, results in extremely vulnerable individual countries and entire world regions (Hoekstra & Chapagain, 2008). For a country, being dependent on resource import from another country – whatever this resource might be – implies becoming increasingly less resilient to external shocks. For instance, Mexico's dependence of external import of water for agriculture, is making the country more vulnerable to the climate change effects. Namely, it causes price volatility which, at the end of the day, have a relatively bigger impact on less wealthy people. To sum up, inequality from resource dependency is created and reinforced between nations by unethical and unsustainable trade. Plus, inequality within poorer countries themselves also increases. Having said that global trade is predominantly dominated by the Global North and its business, oftentimes it is true that such business tend to be owned privately. For example, global virtual-water trade is increasingly governed by the private sector (Boelens, Perreault & Vos 2018), e.g., private multinational companies and retailers. Mexico is not exception. In this country water trade gradually monitored by multinational corporations only. Moreover, certification schemes are also set by those companies which makes it progressively easier for them to hold control on the whole economy. International and national water governance are weakened by this. Such weakness facilitates a loss in local and national democratic control (Vos & Hinojosa, 2016). As the

private sector is profit-maximisation oriented, this benefit some but negatively impacts the majority. For instance, in the case of virtual-water savings between the US and Mexico in grain trade, the relatively advantage such savings might have been positive only for the party that actually makes the bargain, while leaving behind the less strong country, its environment and population. In this way the ethics of water trade becomes then highly questionable, both philosophically and politically. Some scholars named "neoliberal water governmentalities" the increasingly predominant presence of the private sector in water trade (Boelens, Perreault & Vos, 2018). In order to gain competitive advantage in the international market and in name of modernisation, competitiveness and efficiency, governments favour the private sector and, in the case of the Agri-business they incentivise agricultural export. Taking water as an example, Boelens et al. explain that this resource is allocated to "high value added" producers, in other words to those who secure the good for the lowest possible cost (ibid.). On the other hand, local water using communities and producers are penalised through artificial prices and subsidies. As a result, such communities, or weaker actors in the market, are discouraged from investing in local businesses and trusting national governments. In countries that are characterised by incredibly diverse environments, ecosystems, and water availability areas, such as the case of Mexico, the fact that water management is decided on economic grounds alone poses a life dangerous threat to the survival of local communities. Ideally, for a market trade to be efficient and fair, consumers should bear the total cost of production both economically and socially speaking. Nevertheless, in many cases, such as in that of virtual water trade, consumers do not bear the costs associated with water use in exporting countries (Hoekstra & Chapagain, 2008), and neither they are aware of such costs.

In the instance of water, it is impossible to reduce its value to an economic one. If this was the criteria then the market would be left to "autoregulate" and there would ne a shortage of water in Global Southern nations and a conspicuous amount of it in Global Northern ones. For example, for water trade to be ethical, it cannot rest upon a cost-benefit analysis. In order to redistribute this resource fairly, water cannot be monetised. In general, it can be added that every resource which is related to the environment ought not to be monetised. Especially for a vital resource as it is water, human needs must be prioritised. The United Nations convention on watercourses states the following:

> "In the event of conflict between uses of an international watercourse, due regard should be given to the requirements of vital human needs." (Liu et al., 2011, art. 10).

However, the neoliberalist approach can often fall short when it comes to assuring vital human needs. In order to be sustainable, decisions ought to be based on other techniques (Tietenberg & Lewis, 2018), rather than the classic profit-cost analysis.

The case study of virtual water trade in Mexico allows to highlight several implications of the impact the Agri-sector has on climate change as well as that it has on trade between different countries. In particular, it is worth mentioning that imbalances from trading fall – in most cases – on countries of the Global South. Firstly, from an economic standpoint, the rationale behind water trade and how this is managed is entirely profit-centred. In addition, classic economic theorists suggest that when it comes to redistributing resources, this process will occur naturally. For instance, in the case of water, virtual-water trade can save water and result in efficient allocation of this resource at the global level. Mexico, for example, is a water-scarce country but also a net water importer. Therefore, one could argue that virtual-water trade benefits the country. However, a broader examination the country's water policy and management reveal something different. In fact, virtual-water trade in Mexico still causes water depletion and resource overconsumption. Secondly, from the ethical and philosophical standpoint, water trade has several effects that are socially unsustainable. In other words, this type of trade is negative for the country's population. But why is this the case? From the analysis reported in this chapter, it has emerged that virtual-water trade ultimately restraint the power of both communities and individuals, while increasing that of the private sector. Thus, regional vulnerabilities are disproportionally affected in favour of an elite that maintain their profit. Nonetheless, the discrimination does not only happen at the national level. In fact, a further injustice occurs at the global level. As the unsustainable practices within the country effect the less wealthy while benefitting the wealthier, in the international realm, these practices benefit countries of the Global North and make those of the Global South more dependent and vulnerable. In the instance of water used for agriculture in Mexico, the output which is exported to the Global North does not have embedded in it the virtual water used by the Agro-sector. Put simply, countries that buy Agro produce from Mexico, such as the United Kingdom or the Netherlands, are not accountable for the water which is embedded in those products. As a result, Mexico is responsible for tons of

water usage and depletion, while the Western World importers are – on paper – not liable for it. This arguments might be useful to take into account when discussing about solutions to this issue. By all accounts policy making seems to be seen as an efficient way to address the problem. Nonetheless, policy at the national level alone cannot solve the Global South/North discrepancy. Only measures taken at the global level and implement at the national one stand a chance to make Agro-production fair and effective. For instance, a strict anti-water depletion policy at the regional level in Mexico, could seem environmentally viable but could also result in a disproportionate negative effect of the position of this country in the international market. Arguing the latter, however, does not mean neglecting regional and national differences such as scarcity and vulnerability. In fact, those ought to be taken in account in order to craft effective and fair sustainable policy. At the international level, a way of addressing the unfairness and difficulties around water and virtual-water trade is a protocol about water cost pricing. Such a document would include all types of costs (from operational and maintenance to investment) and regional vulnerabilities such as scarcity and depletion levels. The barrier to such policy remains the reluctance of nation-states to partially give up some sovereignty to implement binding supranational norms. This, however, represents a huge obstacle of sustainable and fair development.

Virtual water in the Netherland and the United Kingdom

Having explored the issue of water depletion and virtual water trade in Mexico, it is interesting to briefly analyse these phenomena in the Netherlands and the United Kingdom. The choice of these countries is linked to the fact that both states are neo-liberalist economies with high standards of inter-country welfare and elevated extra-country discriminatory policies. Firstly, the Netherlands is going to be the subject of the analysis. Afterwards, there will be a section on the United Kingdom.

When it comes to water, the Netherlands has closely depended on this resource throughout its history and has been able to empower by managing it well. As reported in Chapter 3, the Netherlands was 11th in the overall 2022 Environmental Performance Index (Wolf et al., 2022) but there was a category that made this country stand out: water

resources. The Netherlands scored 1st for water resources and water management out of 150 countries considered in the analysis. Since this is a nation-based analysis, the results are confined to the internal situation of the country. As a result, the impact the country might have beyond its national territories goes unregistered. Differently, the concept of virtual water that has been used as a parameter in the first part of this chapter, is not only concerned with in-country water management but especially with that impact which is "unregistered". In the instance of water used in the Agro sector, the concept of virtual water trade considers the water embedded in the goods that are being exported and imported. Therefore, it is interesting to investigate whether such an inner-country high performance mirrors the indirect impact the Netherlands has on the environment beyond its borders. According to the academic research "The external water footprint of the Netherlands: Geographically-explicit quantification and impact assessment", about 89% of the country's water footprint is external and only 11% is internal (Oel et al., 2009). In this context, agricultural activity is particularly relevant as 67% of the total water footprint of the Netherlands is related by agricultural goods' consumption (ibid). Focusing on water trade, only 44% of virtual-water import is destined to products consumed within the country. In fact, the remaining 56% of the water imported in the first place is re-exported later. This should not come as a shock being aware that the Netherlands, in 2022, was the 4th world exporter in billion US dollars, after China, the USA, and Germany (ITC, 2023). The impact of external water footprint of the Netherlands is huge. Some researchers have identified water scarce countries that might be particularly affected by the activity of countries such as the Netherlands. Mexico, India, Pakistan, and Sudan are among these. The four countries that have been just mentioned are part of the Global South. It can also be pointed out that – owing to different reasons, spanning from political to environmental – all these nations are in a condition of important disadvantage and vulnerability compared to the Netherlands. Therefore, it could be argued that this is a classic example of systemic inequality between a Global South and a Global North countries. There are two arguments that ought to be explored in this sense. The first questions the Netherlands' position as best water resource and management country according to the EPI 2022. The second is concerned with pure economics that, yet raises ethical concerns: how is a country responsible of water depletion through virtual water trade gaining so much money with its exporting activity? The answers to both questions are complex and therefore

would require investigation through further analysis. Nevertheless, this evidence can be used to suggest some policy corrections in order to make water trade fairer. Above all, a system that quantifies the indirect effect of a country Agro-produce trading activity on other states, livelihoods, and the world is necessary to monitor the phenomenon. At the same time, the principle of "polluters pay" should be applied to the case of water through climate policy. For instance, a country such as the Netherlands that contributes extensively to water depletion, should account for its total water footprint. Whether accounting for this means paying higher prices to affected partners or having to observe a limit to yearly water footprint, is a matter of political choices. The possibility of combining restrictions into a policy package ought not to be excluded either. In fact, policy has appeared to me more effective when highly diversified and crafted for specific areas and environments (He et al., 2006). According to the IPCC 2001, single policy instruments are likely to be insufficient to mitigate climate change. On the contrary, a portfolio of combined policies allows for potential synergies to emerge (IPCC, 2001). This has proven to be particularly effective in countries for countries that face a series of vulnerability issues such as those of the Global South. Contexts like these are often characterised by limited financial and human resources and, for this reason, synergies created by policy packages can be of great help (Dang et al., 2003). Looking at the Agro sector specifically, implementation of policies in other sectors (e.g., renewable energy, energy efficiency, effective land use) might be extremely beneficial for agriculture.

The discourse around water management and virtual water in the United Kingdom is perhaps less straightforward than the Dutch case. In fact, the available literature seems slightly scarce. A case study that exemplifies the relationship between countries of the Global North and Global South in terms of virtual water trade related to the Agro sector, is that of the avocado industry. The trade of this good is a case study that has been receiving growing attention, therefore, it is of academic relevance. Avocado is among the water-intensive products. It is an irrigated crop which has become one of the most imported tropical fruits worldwide during the last twenty years. From 2000 to 2016 there has been a constant increase in international avocado trade which has seen a rise of 435% in this time span (FAOSTAT, 2020). Specifically, Mexico covers almost half of the global avocado production covering more than 40% of the overall output. In Mexico, this causes serious water shortages and other environmental related issues as well as making the

country heavily dependent on a single-crop production (Serrano et al., 2019). A study conducted in 2019 shows that avocado trading is a matter largely related to the relationship between Southern American productors (and then exporters), and Western word importers. On the one hand, Mexico, Peru, and Chile are the main exporters. On the other, USA, EU, Japan, and Canada the biggest importers. The graph below illustrates the state of virtual water exchanges related to avocado in 2016 between the Southern American nations and some countries of the Global North.

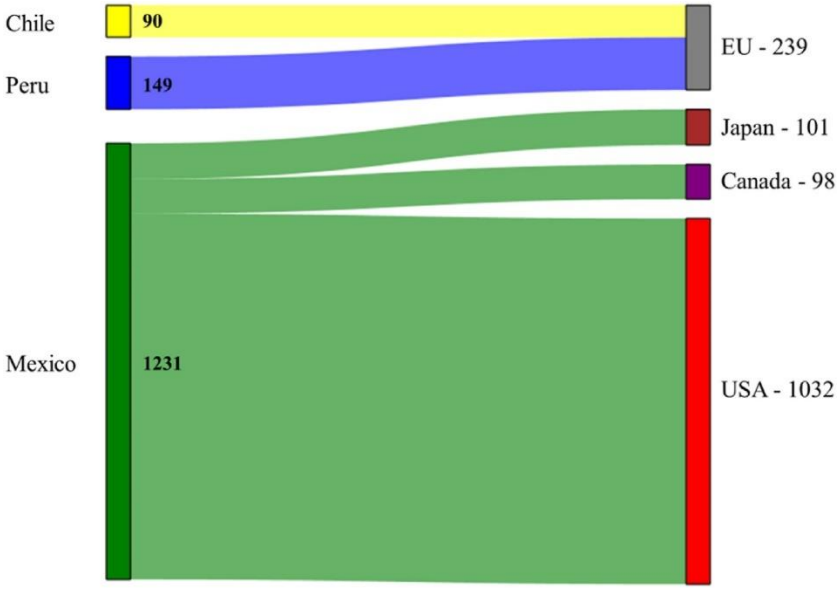


Figure 20: *The largest flows of virtual water associated with avocado in 2016 (MM^3)*
Source: Journal of cleaner production (Caro et al., 2021).

From this illustration it is possible to observe that Mexico is mainly exporting this fruit to the US and that other Southern American economies are the main partners of the European Union. In fact, the graph shows that the Netherlands and the (formerly) United Kingdom import avocado mostly from Peru and Chile. Yet, it remains relevant to look at the U.K. position in terms of Agri-produce import from Southern America as a macro area. The case study on virtual water associated with avocado indicates that the largest importers of this Agro product from South America were indeed the United Kingdom and the Netherlands in 2016 (Caro et al., 2021). The same research indicates that the U.K. was the 3rd net virtual water importer in Europe (ibid.). Considering this evidence, one could argue that the United Kingdom has an important share of responsibility in terms of water usages for the Agro sector, at least when it comes to this production type. To summarise, as explained in the previous chapter, the rationale behind virtual water trade

envisages that water-abundant countries should be those producing and exporting water intensive products such as avocado. This would allow to reallocate water resources and address the implications of water usage in agriculture on climate change (Allan, 2011). However, at the current state, the Agro sector weighs heavily on some countries rather than others. Considering water in particular, water intensive productions are still pursued by countries already facing internal resource shortages. International trade of fruit and vegetables, in this instance avocado, rather than enriching the exporter can worsen both environmental and social conditions of these countries. This is owing to the international Agro business that can worsen environmental conditions as it increases water stress. Also, such system can deteriorate social conditions. In fact, the populations of Global Southern producers are likely to suffer from water shortages. Additionally, their economies are becoming increasingly dependent on exports to the Global North, and this reproduces a system of structural inequality.

The limited analysis of the Agro sector and Agro trading in the Netherlands and the United Kingdom summarised above, is aimed at introducing the discourse of policy to address the impact of the Agro-system on climate change. From this thesis it has emerged that overall, the Global North operates in the Agro industry to the expenses of the Global South. This claim has been backed by the case study of virtual water trade in Mexico and the Netherlands, and by the case study of avocado trade between South America and the United Kingdom. In short, richer countries enjoy a net position of relative advantage compared to more vulnerable and disadvantaged countries. Therefore, one could argue that the Global North holds a bigger responsibility when it comes to the impact of the Agro sector on the environment. For this reason, one could also claim that these advantaged countries ought to be the ones taking responsibility to address climate change. The two main reasons to argued this are several. Firstly, data shows that historically the Global North has contributed enormously to climate degradation (as shown in Chapter 1). Secondly, at the moment the consequences of climate change are effecting the livelihoods of the populations of the Global South disproportionately more than those of the Global North (Chapter 5). Third, the Global North has much more financial and structural resources to implement policy aiming at containing the effects of climate change than the Global South. The final part of this section will therefore investigate on this point.

Crafting effective and sustainable policy is a delicate matter. One of the reasons why this is the case is that the issue of climate change is of a global kind. In other terms, climate change happens everywhere in the world and therefore touches all countries, regardless of the differences there might be among these. Normally, these differences are related to the resources available to face the consequences of the climate catastrophe. In fact, as previously argued, Global North countries are generally advantaged when facing sustainability challenges as they have more resources e.g., capital and infrastructures at their disposal. Since climate change is a global threat, to reduce its impact it is necessary to commit jointly. Efforts from single countries or small groups of nations will not solve the problem. For this reason, global environmental governance is a field which has seen an unpreceded expansion in the last decades. The term global environmental governance comprehends a range of notions. It includes political affirmative action e.g., through policy programmes, but also analytic study of current transformations of global politics in the context of climate change (Biermann & Pattberg, 2008). For environmental governance, it has become crucially important to act at the supranational level because this field does not regard world politics to be confined to governments of nations states (ibid.). On the contrary, they individuate in non-state actors and international institutions the key players for an effective change. This classification refers to experts, scientists, environmental organisations, business associations, cities and so on. The increased participation of these non-governmental actors is creating a situation of growing vertical as well as horizontal fragmentations. This means that there are both a multilevel governance and multipolar governance that are becoming more prominent. Nonetheless, it is worthing remembering that national policy is very important as well. Surely, this has to be accompanied by global governance. However, state-nations and federations remain holders of binding powers. For this reason, ideally, supranational/global commitments should be then translated into national/federal law. In this way, such jurisdiction can be enforced lawfully, and the risk of non-compliance can be limited.

The system of the European Union might be considered a favourable playing field for the transition to a sustainable Agro sector. This can be argued for three main reasons. Firstly, the European Union countries are among the wealthiest countries worldwide. This means that they have got an advantage in terms of resources to implement policy e.g., the financial system. Secondly, the EU is a key player in the international Agro sector market

(Directorate-General for Agriculture and Rural Development, 2023). This means that a change towards a sustainable Agro sector through environmentally friendly policy is likely to have an impact on extra-EU countries as well. This is particularly interesting in the context of trade with South America. Thirdly, from a political and lawful point of view, some scholars say that the European Union is close to a federation (Schuetze, 2021). This is significant for environmental governance as it allows a supranational entity, the EU, to impose binding policy to its member states. As a result, there are few constraints for what concerns nation-state lack of policy enforcement issue. An example of sustainable policy at the European level is 2001 Sustainable Development Strategy. This policy aims at fostering sustainable development within the EU and outside the EU (CEC, 2001). Other examples include the Cardiff Process and the reform of the Common Agricultural Policy of the EU. Despite the European Union seems to be in a favourable position to be an agent of change in sustainable development, many have criticised or regarded its actions as very limited. ActionAid, for instance, has severely criticised the European Union arguing that:

> "[EU policy] are piece-meal reforms which offer little, if any benefit to the world's poor, particularly since they allow the provision of public aid to agriculture in ways which are designed not to reduce overall levels of EU production" (ActionAid Alliance, 2003).

ActionAid claims that the European Union policy of reducing intervention prices is also accompanied by an increase in direct aid payments. As a result, this allows agricultural products to be charged with prices that do not correspond to the real production cost (Adelle & Jordan, 2009) in less wealthy areas, namely countries of the Global South. In this sense, the criticisms of the Netherlands, the United Kingdom, and the Global North as a whole, that have been put forward in this thesis might hold for the European Union too. In systems characterised by high internal welfare and strong liberal economies, the external impact on other countries appears to be easily neglected. Many NGOs support this argument as they claim that international organisations are not prioritising sustainable development problems as they promote liberalisation and growth-oriented policies (Dreher et al, 2009).

Conclusion

Summary

Firstly, this thesis introduced the concept of divide between the Global South and Global North. With a focus on the history of colonialism and international trade exchanges as it is now. The analysis led to a discourse around economic inequality, resource distribution, population growth trends and more. Following, the link tying this phenomenon to climate change was examined.

Secondly, the Agro-sector was analysed in detail. From an economic point of view, the role of the sector in global business was considered. Particularly, the mechanisation of agriculture, irrigation practices and the usage of fertilisers' and the Green Revolution were considered. Following this, the issue of population growth was introduced, and it led to the question: How can agricultural output meet food demand which is increasing proportionately to the increment of the world's population? Ethical concerns related to food distribution at the global level were also discussed.

Thirdly, statistical data on the impact of the Agro industry on Climate Change was presented. The concept of the nation-state underpinned this analysis. The Environmental Performance Index 2022 of Brazil, Mexico, the Netherlands, and the United Kingdom, was used as a key source of information. The agricultural exchanges between these countries were examined with the aim of grasping the indirect environmental effects these may have on one another and on climate change.

Fourthly, the business of the Agro-sector was evaluated with the context of a global market economy. An overview Agro-sector flows globally was provided and followed by an extensive analysis of import/exports trends between Brazil, Mexico, the Netherlands, and the United Kingdom. This led to a key question: What is the indirect environmental impact a country importing Agro-produce from another country has on the latter?

Lastly, this thesis examined some case studies related to the Agro-sector and the role played by South America and Northern Europe in it. The case study of Water Depletion and Virtual Water Trade in Mexico and that of Avocado trade between some countries of Latin America and the United Kingdom were chosen.

Research questions

In the context of the Agro-sector, to what extent is the Global North exploiting the vulnerabilities of the Global South in order to gain advantage?

With regards to the first research question, this thesis first examined the social vulnerabilities present within some agricultural systems of the Global South. After presenting the historical background of the Agro-system, it has emerged that patterns typical of the Global South and Global North divide characterise this food production system. In particular, a huge number of small and medium landowners are unable to cope with the competition as they cannot mass produce. In fact, the Agri-business of the Global North creates a system where smaller stakeholders – especially from the Global South – are unable to keep up with their competitors that engage in huge and unsustainable single crop production practices. As it was pointed out in the case study of Virtual Water Trade in Mexico, solely land-owners who can access water resources can keep up with the production and exportation of Agri-produce. As a result, medium and small-holders are singled out because of the Global North pattern of Agri-production and trading.

Secondly, this research looked at economic vulnerabilities in the context of the Agro-sector and of the Global South and North trade interaction. What emerged from a reading of existing literature is that the Agro-system favours countries of the Global North as opposed to those of the Global South. In particular, the international trade of Agro-produce creates a disparity between wealthier and less wealthy countries. On the one hand, the strength of the Global North allows them to impose as system onto the rest of the world. In this way, the Agro-system is beneficial for wealthy countries whereas it makes developing ones more and more reliant on the first. This happens because the Global North's demand for Agro-produce is high and therefore creates room for competition. Competition in turn, makes internal markets of weaker countries more susceptible to economic shocks and leads to a deterioration of national competition. In other words, the agricultural economy within a country of the Global South becomes an

oligopoly or monopoly and this is caused by a system of production and distribution coming from the Global North. This phenomenon was discussed in the case study of tropical fruit trade from Southern America to Northern Europe.

Thirdly, this thesis investigated the historical nature of the Agro-system and to what extent this system has a neocolonial nature. Such analysis showed that the Agro-business has its roots in the colonial history of the Global North. The Agro-sector is based on an anachronistic neocolonial model: the Neo-colonial Dependence Model which asserts that less economically developed countries, even though politically independent, remain economically dependent from former coloniser countries (Isham, 2022). This relationship makes more developed countries wealthier and increasing powerful, whereas making less developed ones more dependent on the first. This research used the False-Paradigm Model to criticise the Neo-colonial Dependence Model (ibid.). The False-Paradigm Model argues that less developed countries cannot increase their wealth in the same way more developed countries do, because development strategies were set upon them by Western economics theorists and therefore are not beneficial for non-western economies. For instance, basing economic development solely around growth has proven to be detrimental: from a social sustainability aspect because it endangered and weakened populations, and from an environmental sustainability perspective because it does not consider its impact on the natural environment. In the case of Virtual Water in Mexico, for example, high demand for Agri-produce from the country by the Netherlands led to Mexico becoming a water-scarce country. As a result, this benefitted the Global North country as opposed to the Global South one that remained impoverished. In this way, development favours the existence and persistence of divergences between more and less developed nations, in other terms the Global North and Global South (Soderbom et al., 2015). This phenomena is called the Dualistic-Development Thesis (ibid.), and many argue that this occurs in the context of the Agro-sector.

How has the Agro-sector of the Global North exported its emissions to the Global South?

The second research question looked at the Global North "exporting" its emissions to the Global South, both directly and indirectly. Research shows that the consequences of the Agro-sector on the environment is extremely impactful. Therefore, the direct

environmental impact of the Agro-industry is pretty straight forward: every country that produces Agro-produce contributes – to different extents – to climate change.

On the other hand, the indirect impact of this sector is less straight-forward to identify. In this case, Global North countries that import a lot from the Global South seem to have an environmental effect that often goes neglected. Since Global North maintains a high and constant demand for cheap Agro-produce from the Global South, exports increase and so does climate change. At the same time, economic inter-dependency does not allow less wealthy countries to decrease their supply. Such cycle is caused by a system of hyper-globalisation, global trade, and free markets that foster economic interdependence between vulnerable and less vulnerable nations. However, the system not only fails in distributing the environmental impact of the Agro-sector unequally between nations, but it also fails in acknowledging where the responsibility lie. This is due to the fact that importing countries – Global North – keep their national environmental impact records relatively low and within the standards but, in reality, contribute to climate change much more in an indirect manner.

Looking at the Netherlands' inner country environmental performance in 2022, they scored incredibly well compared to the rest of the world. Nevertheless, they also were among the top importers worldwide which makes their indirect impact on the environment much bigger than it is on paper.

The International Dependence Approach of the 70s fails in this instance as it leave less wealthy countries exposed to shocks, vulnerability and dependence, while making wealthy nations wealthier (Soderbom et al., 2015). Global South countries being treated as extensions of the Global North is unfair and unsustainable. There ought to be a change in inter-dependence policy approaches as this would allow a strengthening of national markets of countries of the Global South. Additionally, this leaves room to a more sustainable system of development for the Agro-sector. Economic independence allows crafting of policy that is suitable for particular areas, whereas free and hyper-globalised market bring inequality and unsustainability.

In the case of Latin America, research shows that this area's renewable energy capacity is twice as big as the world's average (Lebdioui, 2022). Integrating renewable energy usage in the Agro-production system would mean decreasing its emissions. The

example of Latin America's energy capacity is just one of the reasons why pushing for political and economic independence of the Global South is important both ethically and environmentally.

To what extent does the responsibility lie with the Global North in addressing the environmental and social issues of the Agro-sector?

This thesis has pointed out that, both historically and contemporarily, the Global North holds a big share of responsibility for the environmental and social impact of the Agro-industry. Compared to the Global South, wealthier countries of the Global North have increased their power and wealthy by reproducing an unequal system of interdependence with less wealthy nations. Therefore, it can be argued that the responsibility of addressing environmental and social issues within the Agro-sector lies with the Global North. Having said this, the manner in which such responsibility should be fulfilled is another matter.

In this thesis, the issue of binding environmental policy and law was briefly touched. The example of state-nation law clashing with supranational commitments was used to explain the practical difficulties of environmental policy implementation. In fact, even though supranational provisions, such as those adopted by the United Nations Climate Change Conference (COP), might lay down useful conditions to address climate change, in reality they have difficult applicability onto nation-states. As a result, the global effort to address climate change lacks unity.

Another point worth touching upon when answering this research question is whether the Global North, given its responsibility to address the climate crisis, ought to impose environmental standards and regulations onto countries of the Global South. This is controversial as many could argue that wealthier countries that have more R&D resources, have, as a result, the capability of crafting effective environmental policy. Nonetheless, research proved that grassroot adaptation results in much more sustainable practices than policy imposed from above does. Additionally, environments vary hugely across areas and regions of the world and therefore sustainable practices in line with regional specificities turn out to be the most effective.

Theoretical weaknesses of the analysis and further research questions

The first weakness of this thesis is related to its intrinsic Eurocentrism. The analysis is carried out on the premise that the Global North ought to take responsibility for climate change when, if fact, the research itself is Eurocentric. Moreover, claiming that environmental policy should be implemented in the Global South means asking less wealthy countries to give up the economic unsustainable system that made the Global North thrive throughout history. For this reason, what this thesis claims might go against economic and social independence there ought to exist between nations and world areas.

However, this argument can be counterbalanced. Generally, research shows that sustainable development not only is beneficial from an environmental point of view, but it can also improve wealth. Studies show that action in land, water and food management have broad room to achieve sustainable development. For this reason, asking Global South countries to comply to different forms of sustainable development can be done in a way that does not benefit the Global North but improves developing countries' economies.

Secondly, in the case of Latin America specifically, agriculture represents over 60% exports in 6 Latin American countries (Lebdioui, 2022). This means that the Agro-sector in this macro area is particularly promising for growth of wealth and sustainability at the same time. The issue that ought to be addressed remains the ultra-dependency of Southern American nations' trade to the Global North. For example, the case study of tropical fruit – Avocado trading – between Brazil and the United Kingdom, is an instance of such dependency within the system of the Agro-industry.

Another aspect of this thesis that might be object of discussion is about factors related to food production and distribution as a whole: in particular aspects such as world population growth. The question stemming from this is the following: Is this thesis possibly not placing enough importance on increased yields that were created through environmentally disruptive developments in the Agro-sector? Part of this thesis discussed data related to worldwide increase in population growth that ought to be accompanied by food production growth as a result. In this scenario, some could argue that a sustainable Agro-production is not more important than a large-scale Agro-production. It could be claimed

that in a context of growing world population the priority is feeding such population instead of investing in sustainable food production techniques. Is it fair to ask governments to take measures that will potentially decrease crop yields in the short terms when these governments are already facing many other issues such as increasing food demand?

Addressing this argument is complex. One of the claims to consider is related to the fact that, worldwide, lack of nutrition for some is not caused by small Agro-production but rather by an unbalanced resources distribution across nations. Data shows that the food availability of the Global South and the Global North are, by far, tremendously unbalanced. For this reason, it can be said that governments should be able to face the issue of growing food demand caused by population growth, not by augmenting food production by through levelling of food resources distributions across the world. It goes without saying that the complexity of such instance is beyond the scope and possibilities of the thesis. Food resources distribution worldwide and especially with an emphasis on the disparity between Global South and North, might be a point of departure for a new research question to address in further studies.

A third critical point of this thesis relates to the choice of Brazil and Mexico as Global South countries: Are Brazil and Mexico two accurate examples of the Global South? It can be claimed that this is not the case. Brazil, for instance, has been the most successful country in developing a green manufacturing sector in the world so far. This is also due to the fact that this country has access to a huge market sector to begin with. The country has in fact a huge place on the global trade scene and therefore might not be suitable to represent countries of the Global South. Nevertheless, this dissertation focused on Brazil as part of a macro-area which is insightful in terms of food-production and food trade: Latin America. Brazil was not used an example od the whole Global South but contextualised in the scenario of the Agro-industry in South America. Lastly, both Brazil and Mexico were considered in relation to two specific case studies: that of Avocado Trade and that of Virtual Water Trade. This research aimed at exploring the Agro-sector with an in-depth analysis of two countries of Northern Europe, namely the Netherlands and the United Kingdom, and two of Latin America, Brazil, and Mexico.

In addition, some could argue that the idea of the Global South is too deterministic itself. As a matter of facts, every country has its own characteristics, including strengths and vulnerabilities which cannot be compared across large number of countries and areas. However, this is Global South/Global North model was chosen for this research as it mirrors broader trends of powerful countries exploiting less powerful one. Having said this, different models in further research might be used as more suitable for other issues.

The last issue that could be raised in relation to this dissertation is the following: Is ignoring China possible, given its influence on Agri-trade particularly in Brazil? Research shows that China is slowly but steadily supplanting the USA as the region main trading party of Latin America (Marshall, 2016). For this reason, future research might have to focus on the growing influence of China as in this thesis this geopolitical development has largely been ignored.

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