The Role of Business in the Plant-Based Oils Sector – A Socioenvironmental Analysis

by

Stephen Gray

Supervised by

Dr. L. Anders Sandberg

A Major Paper submitted to the Faculty of Environmental and Urban Change

in partial fulfillment of the requirements for the degree of Master in Environmental Studies

York University, Toronto, Ontario, Canada

August 23, 2024

Abstract

Plant-based oils are a family of products widely utilized across the globe, a common staple in both home kitchens and within commercial applications. Despite this, such oils are perhaps scrutinized more for their nutritional qualities than for their socioeconomic and environmental impacts. With demand expected to rise over the coming decades, ensuring that the production of plant-based oils is conducted in a sustainable manner will be paramount to reducing the industry's environmental impact. My research examines the current state of the plant-based oil industry, and the environmental and social trends present within it, as a means of informing corporate action. Through the use of an intensive literature review, I analyse the GHG emissions, environmental implications, and social impacts which factor into the cultivation and production of four major plant-based oils, palm oil, olive oil, canola oil, and soybean oil. Reflecting on the historical evolution of how society perceives the role of business, I conclude that in its current form, the production of plant-based oils is overly reliant on fostering environmental and social inequalities. Although clear opportunities for change exist, businesses will need to take the initiative and factor in the needs of both current and future generations in order to combat the plant-based oil industry's deep-rooted use of socioenvironmental exploitation.

Foreword

Throughout my time as an undergraduate student at York within the BES program, the role of business in contributing to environmental decay was a reality which greatly disturbed me. It seemed, in my eyes, that despite the great tragedy of the commons that was clearly being played out before us in real time, corporate action seemed more at ease with managing profit margins and proposing environmental pledges with the same gravity and weight of stale air. Because of this, when I initially began the MES program, although I understood that the interconnected nature of business and sustainability was an area of interest I wished to explore, I was divided on the best way to do so. At first, I felt that GIS and remote sensing was the answer, a premise I later built upon by investigating the role of energy efficiency and energy advising. In the end however, I believe I found my true direction once I enrolled in the Business and the Environment diploma alongside the Schulich School. By integrating my passion for sustainability with a better understanding of corporate business practices, I've managed to gain a newfound appreciation for the role that business can play in mitigating the effects of climate change and fostering sustainable action, provided of course that such practices are made with true intent.

My Major Paper seeks to combine my interest in corporate sustainability practices with my love for cooking, allowing me to take a deep dive into the manner of how sustainability assessments can be performed and how they can serve to inform the social and environmental policies of businesses as a whole. Ultimately, my research has allowed me to put the theory and experiences I have gained throughout my time in the MES program into practice, serving to cap off my time within the program by furthering my own knowledge and hopefully contributing to a greater understanding of the socioenvironmental state of the oilseeds sector.

Dedication

This Major Paper is dedicated to current and future graduate students within the Faculty of Environmental and Urban Change.

Acknowledgements

First and foremost, I want to thank Professor Sandberg and Professor Winfield for their contributions and support in guiding my Plan of Study and Major Research to their conclusion. I also wish to offer my gratitude to Professor Martin Bunch, whose insights were instrumental to making my introduction into the program a smooth one. Lastly, I want to thank my family and friends, as without you all, I would not be where I am today.

Table of Contents

Business, the Environment, and Society - The Evolution of Corporate Purpose

The matter of defining whether or not a business can be considered successful is a question not easily answered. This is not because it may be especially difficult to arrive at an answer, but instead due to the fact that the idea of what exactly constitutes a successful business is one that may differ wildly depending on the perceptions, values, and lived experiences of whoever is asked. While in the past, determining whether a business was successful was likely dependent on a select few factors, such as the rate of demand toward the goods or services being offered, the ability to consistently generate a meaningful profit margin, and the ability to stand out amongst competitors, today, a business's standing may be defined by a much wider range of parameters. That is not to say that a business with an outstanding history of financial performance and consumer popularity such as Microsoft or Starbucks is not a successful one, but rather that, in today's society, the definition of success can extend beyond the purely economic to also include environmental and social considerations. Said considerations are not set in stone however, and conflict can arise depending on how exactly one views the role a business should hold in relation to the world around it, the idea of corporate purpose.

The Original Corporate Mindset – Shareholder Theory.

In their work, *Good Business,* Pfarrer (2010, p. 86) highlights that what is known today as shareholder theory can be said to have emerged from the writings of the enlightenment economist Adam Smith, responsible for the development of "free market" economics. The shareholder theory of corporate purpose is fully founded on the notion that businesses should be unequivocally managed in a manner that is informed by self-interest and the maximizing of profit (Pfarrer, 2010, p. 87). Proponents of shareholder theory believe in the presence of an open market that is free of government regulation and interference. When businesses are guided by the pursuit of profit and the generation of shareholder wealth, society at large will also benefit (Pfarrer, 2010, p. 87). Such a perspective was largely popularized by the Chicago School of Economics and especially championed by the noted economist Milton Friedman, who espoused the belief that the role of business should be business itself (Pfarrer, 2010, p. 87). To Friedman, it was not the role of business to solve societal problems and that to do so proactively was detrimental to corporate success as it wasted shareholder money and squandered wealth (Pfarrer, 2010, p. 87). Rather, shareholder theory states that it is the role of government and NGOs to explicitly foster positive social and moral change, and that to saddle businesses with such responsibilities is a burden to the economy and will harm society in the long term (Pfarrer, 2010, p. 87).

A Competing Perspective – Stakeholder Theory.

Gaining popularity throughout the 1970's and 80's, a different idea on the notion of corporate purpose was proposed, that of stakeholder theory (Pfarrer, 2010, p. 88). Directly conflicting with the perspective held by shareholder theory, stakeholder theory instead promotes the idea of achieving greater corporate success by taking into account the interests of a business's stakeholders, defined as the "individuals and groups who affect or are affected by a firm's actions" (Pfarrer, 2010, p. 86). Although stakeholder theory does recognize the importance of financial success, it aims to guide decision making away from a singular pursuit of pure profit while emphasising the relationship a business can have towards its employees, suppliers, customers, financiers, and community (Pfarrer, 2010, p. 89). Ultimately, stakeholder theory is founded on the belief that by recognizing the interconnected nature a business can have with its stakeholders and ensuring that a business creates value for all involved, not just shareholders, society at large will benefit (Pfarrer, 2010, p. 89). Importantly however, it should be noted that who exactly counts as a stakeholder and the importance assigned to different stakeholder perspectives can change over time, with certain stakeholder views potentially growing to hold more power and perceived importance over others (Pfarrer, 2010, p. 89).

Further Evolutions of Stakeholder Theory – CSR and ESG.

Following the emergence and growth of stakeholder theory in the corporate world, the concept of CSR, standing for "corporate social responsibility", has subsequently gained popularity as a means to more easily quantify the actions of a company in generating positive change for its stakeholders (Pfarrer, 2010, p. 91). Although Pfarrer notes that the idea of CSR metrics often encompasses the realms of environmental, social, and economic change, such as a commitment to utilize more sustainable materials in the production of a product, the meaning of CSR remains loosely defined. In their work analysing the application of CSR theory, Alfry et al. (2020, p. 1-3) highlight the fact that CSR can vary in being both meaningful and meaningless overall. On one hand, they note that given our interconnected and online society, public awareness of societal ills and misdeeds have made the presence of a CSR strategy among businesses vital to ensure positive public relations and illustrate a commitment to fostering beneficial change, both necessary for competitive advantages (Alfy et al., 2020, p. 1-3). As a result, Alfry et al. (2020, p. 2) see CSR as required "due diligence for preserving the firm's license to operate, avoiding reputational damages, building loyalty, and maintaining competitive positioning'. Through the development of CSR, businesses are now perceived to hold a role in society beyond that of simply generating profit and gaining additional responsibilities towards cultivating positive change in society (Alfy et al., 2020, p. 1-3). On the other hand, they note that the nebulous definition of CSR can allow for the spread of ambiguous commitments, allowing companies to simply promote their commitments to "sustainable growth" or "fostering participation" without following through with the action necessary to produce meaningful results (Alfy et al., 2020, p. 3).

As a result of the ambiguity surrounding the idea of CSR, the concept of ESG (environmental, social, governance) metrics have emerged in kind, acting as a major driving influence towards corporate success by influencing investor decision making and public knowledge surrounding a company or industry. In essence, ESG serves an analysis of a company's overall sustainability and social performance. In the same manner as assessing a company's balance sheet and financial performance, ESG serves to provide investors with a baseline understanding of how exactly a company fares in regard to its environmental and social contributions, such as through the presence of forced labour, diversity in the workplace, and the noted presence of deforestation and pollution, among other metrics (Zumente & Bistrova, 2021, p. 2). In theory, ESG works to highlight the most prominent corporate businesses making genuine strides towards positive societal change while also serving to place a spotlight on businesses placing less emphasis on CSR, incentivising a commitment to ESG practices among businesses in each industry in order to gain a competitive advantage.

Future Perspectives – Business as Steward.

With the rise of the United Nations SDG (Sustainable Development Goals) circa 2015, further questions can be raised on where exactly the limits of defining stakeholderism should lie. Put forth by the United Nations, the SDGs are an integrated framework defining global sustainable development priorities and aspirations (GRI et al., 2015, p. 7). Under the SDGs, the United Nations has argued that the time for conducting business as usual has passed, and that a business which serves to "advance sustainable development through the investments they make, the solutions they develop, and the business practices they adopt" will ultimately succeed over their competitors in the long term (GRI et al., 2015, p. 6). Implicitly, this has served to place public pressure towards changing the role of successful businesses as being defined by their contributions to transformative, measurable socioeconomic and environmental change. As quoted by the UN Secretary General, Ban Ki-Moon, "Business is a vital partner in achieving the SDGs. Companies can contribute through their core activities, and we ask companies everywhere to assess their impact, set ambitious goals and communicate transparently about the results." (GRI et al., 2015, p. 4). Despite the unveiling of the UN SDGs, an argument can be made that the current practices of CSR and stakeholderism can undergo further improvement, with Abrudan et al. proposing broadening the concept of stakeholder theory to take into account the role of business in contributing towards the well-being of future generations. In their review of ESG and sustainable finance literature, Abrudan et al. (2021, p. 17) note there is a lack of consideration regarding future generations' interests in the theory and practice of sustainable finance, with the authors posing the conclusion that failing to include generational fairness in modern ESG metrics represents an ethical failure that should be addressed. A similar conclusion was reached by the UN under their pending Declaration on Future Generations, which, among other commitments, affirms the need to "respect, protect, and fulfil the needs, interests, and rights of future generations." (United Nations, 2024, p.4). Ultimately, in our current era of climate awareness, perhaps no greater contribution can be made towards the rights and wellbeing of future generations than by working to ensure one's business is both socially and environmentally sustainable, setting a new standard for other businesses to strive for.

Methodology

This research paper is founded on the basis of literature review, primarily relying on works sourced from academic journals, as well as government publications and other grey literature. In regard to the four plant-based oils central to my research, that being, palm oil, olive oil, soybean oil, and canola oil, they were selected primarily on the basis of popularity, with palm, soybean, and canola oil being among the most widely produced and consumed oils today. In the case of olive oil, it was selected on the grounds of its rising acceptance globally, being perceived as possessing a large variety of beneficial nutritional and culinary qualities. The guidelines directing my sustainability analysis of these plant-based oils fall into the following categories: History and Usage, GHG Emissions, Environmental Impacts, and Social Harms. These four areas of investigation were ultimately decided upon as they provide a well-rounded foundation, allowing the investigation to involve a wide range of environmental and social sustainability criteria, such as biodiversity impacts and the presence of labour violations. Such a holistic form of analysis is important given that the concept of sustainability itself is not purely limited to environmental qualities, as socioeconomic sustainability will also be required in order to ensure that future generations are able to meet their own needs in a fair and free manner.

Plant Based Oils – A Vital Product with Future Demand

Although they may not be under wide scrutiny in the public eye, save for their nutritional benefits, plant-based oils are a family of consumables which hold an immensely underestimated role in everyday life. The role of fats in the human diet is of major importance, aiding in a variety of vital bodily functions and processes. Fats are known to contribute to the compounds necessary for immune and inflammation responses, assist cells in the storage of energy, provide a number of fatty acids required for the maintenance of good health, and allow for the absorption of key vitamins (Bajzeli et al., 2021, p. 645; Meijaard et al., 2022, p. 2). Dietary fatty acids can be categorized based on the specific type of bond structure they hold, falling into the descriptor of saturated, monosaturated, and polysaturated (Bajzeli et al., 2021, p. 645). As a means of identification, fats containing a higher portion of polysaturated fats are oils, while those containing a greater number of saturated fats are solid, for example, butter (Bajzeli et al., 2021, p. 645). In accordance with their storied role towards human health, plant-based oils also hold a storied history, with the first recorded use of vegetable oils able to be traced to 7,000 BC in Mesopotamia, first finding use in the form of cosmetics (Cerone & Smith, 2021, p. 1). Since then, the production and consumption of plant-based oils have endured throughout the centuries, from the ancient Greeks, to feudal China and Japan, to Europe during the enlightenment, and beyond (Cerone & Smith, 2021, p. 1-2). With the advent of refrigeration and the hydrogenation process, among other innovations, both the quality and extraction efficiency of plant-based fats and oils were improved (Cerone & Smith, 2021, p. 3). This led to the introduction of shortening and margarine, providing an affordable and palatable source of fatty acids and greatly altering the human diet (Cerone & Smith, 2021, p. 3).

Within their role as consumables, plant-based fats are used as cooking oil and within a multitude of food products, especially processed and ultraprocessed foods (Bajzeli et al., 2021, p. 645). Outside the food industry, they can be used in industrial lubricants, in soaps and cosmetics, and in biofuel (Bajzeli et al., 2021, p. 645). Given their wide range of applications, the global production of vegetable oil increased by 125% from 2000 to 2020, totaling 208 million tones according to the Food and Agriculture Organization of the United Nations (FAO, 2022, p. 14). Such an increase is expected to grow even further, stemming from the outsized role fats play in the modern diet (Cerone & Smith, 2021, p. 3). Today, it is estimated that around 25-30% of all daily energy required by the human body is supplied by fats (Meijaard et al., 2022, p. 1). As of 2022, it was noted that while approximately 45 million tons of fat per year is needed to supply dietary needs worldwide, this is projected to grow by an additional 88-139 million tons by 2050 as the global population increases (Meijaard et al., 2022, p. 1). In regard to the sourcing of dietary fats, of note, it is estimated that around 80% of all fats produced for the human diet are derived from plant-based sources, making the sustainable cultivation of plant-based fats a key issue to confront before the pressure of extreme future demand constrains corporate decision making (Meijaard et al., 2022, p. 1).

Palm Oil

History and Usage

An all-season, perennial, and fruit producing crop, oil palm has endured as a reliable food source for over 7000 years (Murphy et al., 2021, p. 1; Qaim et al., 2020, p. 322-3). Although notable for both its long lifespan exceeding 25 years and uniquely efficient land-use footprint, the oil palm has a relatively limited area of cultivation, with ideal growth conditions spanning areas of high rainfall along the equator (Murphy et al., 2021, p. 1-2). Initially introduced to Malaysia and Indonesia as a cash crop under British colonial rule, oil palm plantations saw steady growth throughout the 1900s (Murphy et al., 2021, p. 1-3). However, it was only until the early 2000s that oil palm underwent a meteoric rise in demand exclusively powered by a single one of its byproducts, palm oil (FAO, 2022, p. 10). Stemming from the fruit of the oil palm, two main types of palm oil are produced. The first, what is widely regarded as palm oil, can be extracted from the flesh of the fruit and results in around 90% of the total oil produced (Qaim et al., 2020, p. 324). The second oil, known as palm kernel oil, is extracted from the kernel/seed of the fruit and composes the remaining 10% (Qaim et al., 2020, p. 324). Where both of these byproducts stand out, is in their immense versatility across all manners of commercial and industrial applications and highly affordable nature. In the case of palm oil, it possesses a highly specific array of fatty acids and triacylglycerols, that, combined with a high smoke point of 230 degrees, makes it highly adaptable for food products requiring a stable source of fat in either liquid or solid form (Ogan et al., 2015, p. 27). Highlighting this, as of 2023, it was estimated that around 60-75% of all palm oil was used for the purpose of food products (Bausano et al., 2023, p. 5). Regarding palm kernel oil, it can be used not only in cosmetics and soaps but also as a cooking oil, while the kernel itself can be processed into an ingredient for animal feed once all oil has been extracted (Bausano et al., 2023, p. 5). Augmenting its versatile qualities is the fact that oil palm is an immensely productive crop. Oil palm can provide up to a 10 times higher yield of oil than other oilseed crops per area of cultivated land, producing globally an estimated 81 million tons of oil from approximately 19 million hectares of land, making it more cost effective than competing oilseeds (Murphy et al., 2021, p. 1-2; Ogan et al., 2015, p. 27). Because of its efficient, cheap profile for cultivation, demand for palm oil fruit has risen immensely, with the Food and Agriculture Organization of the United Nations recording a 251% increase in demand since 2000 (FAO, 2022, p. 10). Far from a temporary fad, from 2006 onward, palm oil has consistently been the most produced vegetable oil in the world and demand has been projected to increase further, with worldwide consumption expected to reach 156 million tons by 2050 (Bausano et al., 2023, p. 5; Hong, 2023, p. 447). Crucially however, due to the highly specialized environmental niche required to cultivate the oil palm, an estimated 85% of all oil palm is grown in only Indonesia, Malaysia, and Thailand, with the amount of land dedicated to palm oil plantations continuing to grow at a rate between 1.4-1.8% each year (Alcock et al., 2022, p. 10; Bausano et al., 2023, p. 3; Murphy et al., 2021, p. 1-2). However, oil palm production has slowly spread to other countries along the equator with suitable conditions for growth, mainly in Africa, with plantation owners hoping to benefit from the lucrative industry (Bausano et al., 2023, p. 3; Murphy et al., 2021, p. 1-2).

GHG Emissions

When evaluating the potential greenhouse gas emissions resulting from the palm oil industry, it is vital to note that for this particular oilseed the range of GHG emissions is highly dependent on the prospect of land use change. In their 2022 meta-analysis of available life cycle data and existing literature surrounding palm and other vegetable oils, Alcock et al., (2022, p. 9-10) hypothesized that the potential GHG emissions from palm oil production had a median of 3.76kg CO2e per kg of refined oil, but that the potential emissions resulting from land-use change could range from as little as 0.87kg to as much as 28.81kg of CO2e depending on the soil type involved in the cultivation process. While for mineral soils, the effect towards GHG emissions was fairly low, ranging from 0.87-1.81kg of CO2e, for oil palm cultivated involving the displacement of peat soil, GHG emissions were far greater, at 22.75-28.81kg (Alcock et al., 2022, p. 9). Such findings were corroborated by Lam et al.'s (p. 831-833) 2019 study of the GHG emissions surrounding palm oil cultivation in Indonesia, which found that land use change from the conversion of peat soils and swamps was the main driver of emissions.

The reason for land use change holding such a high degree of influence over the rate of GHG emissions surrounding the production of palm oil lies in the similar biomes of Malaysia and Indonesia, with both countries possessing a high degree of peatlands (Cooper et al., 2020, p. 2-3; Lam et al., 2019, p. 831, 833; Warren et al., 2017, p. 1). Peat swamp forests are unique in that they act as vast carbon sinks, holding an estimated amount of 50-105 gigatons of CO2 worldwide (Cooper et al., 2020, p. 2-3; Warren et al., 2017, p. 1). When drained or subject to burning in order to clear away undesirable land, stored CO2, along with CH4 and N20, are then released into the atmosphere (Warren et al., 2017, p. 2). Following this conversion, the removal of peatlands subsequently has a negative effect on the underlying soil, increasing the level of oxygen, which results in the rapid decomposition of organic matter, releasing further CO_2 (Murphy et al., 2021, p. 8). In the case of the Malaysian and Indonesian palm oil industry, given the high rate of international demand for palm oil, farmers, both smallholders and large industrial plantations have taken to clearing away peatland to allow for further land for cultivating increasing amounts of oil palm. Although oil palm has a low land footprint overall, the specific targeting of peatlands has a disproportionate effect on the emissions surrounding palm oil. Lam et al. (2019, p. 832) found that if such expansion were to be halted, the GHG footprint of Indonesian palm oil would drop to 3.2 t of CO_2 compared to 6.9 t should the 2019 rate of land use change continue.

Aside from the influence of LUC, the second overwhelming contributor to the GHG footprint of palm oil is that of palm oil wastewater effluent, also known as POME (Lam et al., 2019, p. 833). A byproduct of the oil processing phase, POME is mixture of water, assorted solid wastes from the oil palm fruit, and oil (Hosseini & Wahid, 2015, p. 773-777). POME is both highly acidic and toxic, resulting in a necessary treatment phase before it is able to be disposed (Hosseini & Wahid, 2015, p. 773-777). In approximately 85% of palm oil mills, this is achieved through open digestion, where POME is stored in open air ponds (Hosseini & Wahid, 2015, p. 777). However, through such an open-air system, the decomposition of organic materials within the POME results in large amounts of methane released into the atmosphere (Hong, 2023, p. 449; Hosseini & Wahid, 2015, p. 777). Overall, these two major contributors, LUC and POME, disproportionally contribute to nearly all of the GHG footprint of palm oil, with a study of plantations in Cameroon finding that LUC composed an estimated 77.6% of all emissions, with POME resulting in 21.2%, the final 1.2% of emissions resulting from the application of fertilizers (1%), fuel consumption during the processing phase (0.14%), and electricity use (0.04%) (Acobta et al., 2023, p. 5). This ranking of GHG contributors was also noted in both Malaysian and Indonesian palm oil.

Environmental Impacts

In 2004, a collective of oil palm cultivators, manufacturers, investors, retailers, NGOs, and other stakeholders within the palm oil industry came together to form the Roundtable on Sustainable Palm Oil [RSPO] (Delabre & Okereke, 2019, p. 1-3; RSPO, 2022, p. 1). With the mission of "promoting the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders", the RSPO has become the de-facto organisation linked to the prospect of environmentally friendly palm oil production (Delabre & Okereke, 2019, p. 1-3; RSPO, 2022, p. 1-2). To achieve this aim, the RSPO underlines its promise to identify and counteract the damaging socioeconomic and environmental effects associated with the palm oil industry by enforcing a series of certification schemes as well as a standardized form of sustainability auditing (Delabre & Okereke, 2019, p. 1-3; RSPO, 2022, p. 1-2). Under the RSPO's current system, in order for producers of palm oil to gain sustainability certification, applicants must first conduct a multi-stakeholder sustainable impact assessment for all existing operations, form mitigation plans in order to address any identified damaging socioeconomic and environmental impacts, and repeat this process when undertaking any new plantation developments (Delabre & Okereke, 2019, p. 2-3). In addition, the RSPO mandates that any fully certified producers of "sustainable palm oil" must not have replaced or converted any areas of primary forest, or those assessed as being of a "high conservation value" (HCV), to plantation land since 2005, with dated record keeping required for all expansions (Azhar et al., 2017, p. 462;Murphy et al., 2021, p. 4-5). In the wake of the RSPO's foundation, the certification scheme has proven popular among larger plantation owners, with the majority of non-smallholder companies holding certification (Azhar et al., 2017, p. 462; Murphy et al., 2021, p. 4-5).

However, despite the popularity of the RSPO, concerns have been raised not only about the overarching impact of the palm oil industry towards the stability of Malaysia and Indonesia's biodiversity, but also towards the effectiveness of RSPO certification as a means of enforcement (Azhar et al., 2017, p. 462). In their 2020 study, Qaim et al. (p. 326) noted that over the last 40 years, the cultivation of oil palm accounted for an estimated 47% of deforestation in Malaysia and 16% in Indonesia. Since the formation of the RSPO, major corporations involved in the palm oil industry have been identified continuing to grow oil palm on lands previously subject to deforestation in direct conflict with RSPO standards (Azhar et al., 2017, p. 462). Rather than serve as an outlier, the continued connection between palm oil cultivation and deforestation appears to be the norm in the wake of the RSPO. As late as 2015, researchers have noted the presence of fraud and collusion between auditors and oil palm cultivating companies (Azhar et al., 2017, p. 462). It was also found that producers often use deliberately misleading information to disguise the continued presence of deforestation parceled with the expansion needed to grow additional oil palm. Through GIS based remote land analysis, Gatti & Velichevskaya (2020, 1-2) found that the majority of certified sustainable palm oil producers within Borneo and Sumatra cultivated oil palm on land noted to be tropical forests in the 1990's, with 92.3% of land designated as tropical forests in 1984 within Indonesia having been converted to palm plantations by 2019. In addition, research noted that many companies are able to skirt the RSPO's land use requirements by growing oil palm on forested land recently logged for timber (Gatti & Velichevskaya, 2020, 1-2). The same harm also extends to peatlands, as across the Malaysian peninsula Borneo, and Sumatra, only 29% of pre-existing peatlands remained as of 2015 (Warren et al., 2017, p. 2). Lastly, the vast consequences towards biodiversity associated with the palm oil industry can be noted to be especially damaging due to the vastly simplified monoculture such plantations promote. Monoculture plantations are by nature more susceptible to environmental disturbances than the biologically diverse forests and peatlands they displace (Azhar et al., 2017, p. 458; Qaim et al., 2020, p. 326). Furthermore, oil palm plantations lack the complex canopy layer, undergrowth, and vegetation, needed to support more specialized organisms, for example, the Sumatran tiger and Bornean orangutan (Gatti & Velichevskaya, 2020, p. 2; Qaim et al., 2020, p. 326).

Another point of concern related to the production of palm oil lies in the generation of pollution. Not only connected to reducing biodiversity, the conversion of forest and peatlands associated with palm oil production has also been found to have adverse contributions towards regional air quality. Farmers in the palm oil industry often rely on starting fires to quickly and cheaply clear forested land, producing large amounts of smoke and other noxious gases (Murphy et al., 2021, p. 8). One other major source of pollution lies in the impact that palm oil mill effluent (POME) has towards the environment if improperly treated and disposed of. In addition to contributing to the significant release of GHG emissions, despite being highly biodegradable, POME is an initially acidic byproduct that requires specialized treatment in order to be considered safe for disposal without harming the environment (Hosseini & Wahid, 2015, p. 777). Despite this, palm oil mills have been recorded dumping raw, untreated, POME. With an ability to deplete oxygen that is 100 times more powerful than raw sewage, disposed improperly treated POME has been found to have a negative effect on the microbiological and chemical properties of soil, reducing fertility (Madaki & Seng, 2013, p. 242-243). Furthermore, when discharged into ponds, rivers, or other sources of water POME has been found to harm both reptiles and fish, as well as reduce waterborne biodiversity (Madaki & Seng, 2013, p. 242-243).

Social Harms

Although the palm oil industry is most notable in the public eye for the various environmental problems associated with it, significant and deeply ingrained socioeconomic harms enabled by producers can be found underneath the surface. In their *2019 Trafficking in Persons Report*, the U.S Department of State (p. 310) found that forced and child labour remain deeply ingrained within the production of palm oil. In Malaysia, local traffickers were found to use misleading information to trick men, women, and children, into forced labour on multiple plantations (Department of State, 2019, p. 310). Instances of debt bondage, threats, improperly vague employment contracts, violence, involuntary overtime, and willing police collusion were found as common means of coercion throughout the palm oil industry in both Indonesia and Malaysia, enabling the continued mistreatment of migrant and local workers (Department of State, 2019, p. 128, 188, 251, 310, 318). These results are corroborated by Amnesty International, which in 2016 found evidence of forced and child labour linked to palm oil plantations certified as sustainable under the RSPO (Gottwald, 2018, p. 1). In the case of child labour, in their work *Illuminating Complex Governance in Palm Oil Sector and the Impacts on Child Labour*, Jamal (2023, p. 186) notes the practice of palm oil companies in Malaysia targeting children from poor villages to work for a reduced salary, often with no safety equipment or training (Qaim et al., 2020, p. 332). Workers not subject to forced labour still often face oppressive and illegal terms of employment, given the existence of "casual workers" (Gottwald, 2018, p. 3-6). Throughout the palm oil industry, certain workers, often women, are labeled as under "casual employment", receiving less pay (usually under minimum wage) and holding no employee benefits despite undertaking many of the same jobs as regular workers (Gottwald, 2018, p. 3-6). Contracts for casual workers are usually informal and lacking clearly noted terms, with casual workers often not being recorded on lists of employees among plantations, making tracking the use of such practices difficult (Gottwald, 2018, p. 3-6).

Further concern can be found with how the use of sustainable impact assessments (SIAs) are carried out within the palm oil industry. SIAs are used to identify and mitigate the social effects of development projects (Delabre & Okereke, 2019, p. 4). Although touted by the RSPO as being a highly representative process involving the participation of multiple stakeholders, including affected workers, farmers, and populations, in reality, the current form of palm oil SIAs appears to be mainly performative at worst and highly inconsistent at best (Delabre & Okereke, 2019, p. 2-9). In their research into SIA assessments conducted for the RSPO, Delabre and Okereke (2019, p. 2-9) found that both involved consultants and NGO's within the SAI process held differing and shifting perspectives on who should be considered a valid stakeholder and made a participant within the SIA. Whether or not workers, suppliers, contractors, and other bodies should be consulted often varied. Even when a diverse variety of stakeholders had been decided upon, Delabre and Okereke (2019, p. 10) noted that often, SIA consultants only aimed to consult with village heads and chiefs rather than the full village itself, as only their support would be needed to ensure approval. In some cases, this involved the use of threats to secure support (Delabre & Okereke, 2019, p. 10). In addition, negative bias towards the consultants themselves, due to perceived connections to larger palm oil companies, often left groups of participants hesitant to involve themselves (Delabre & Okereke, 2019, p. 10). Notably, in order to prioritize efficiency and conduct the SIA in a timely manner, consultants were found to not only exclude vital stakeholders such as indigenous groups, protestors, and women, but often held SIA consultations only after the development projects associated with them had already begun to move forward without prior approval (Delabre & Okereke, 2019, p. 13).

Olive Oil

History and Usage

Coexisting alongside humanity as far back as 5000 years ago, the olive family has a wide diversity of species, approximately 600 in total (Uylaser and Yildiz, 2014, p. 1092). Known as one of the oldest trees to be cultivated throughout human history, the olive tree has held a unique role as a staple in the Mediterranean for centuries (Uylaser and Yildiz, 2014, p. 1092). Consumed both in raw form as well as through the consumption of olive oil, olives not only form the unique backbone of the Mediterranean diet, but now are widely utilized across a variety of cuisines across the globe (Neves & Pires, 2018, p. 102; Uylaser and Yildiz, 2014, p. 1094-1095). Although olive oil is well known for its uniquely fresh flavour, perhaps the most enduring reason for its popularity lies in its known health benefits. Olives, and by extension olive oil, contain a beneficial plant compound known as a polyphenol (Neves & Pires, 2018, p. 102; Uylaser and Yildiz, 2014, p. 1094-1095). The polyphenols in olives are recorded to have a positive effect on the body by acting as an antioxidant, being associated with a lower risk of certain cancers, heart disease, and towards lowering inflammation (Uylaser and Yildiz, 2014, p. 1096). In addition, olive oil contains a high amount of monounsaturated fatty acids, widely considered to be healthier for the human body than both saturated and trans fats (Neves & Pires, 2018, p. 102; Restuccia et al., 2022, p. 1; Uylaser and Yildiz, 2014, p. 1097). As a greater understanding of the nutritional benefits of olive oil has spread beyond the Mediterranean, so too has the rate of demand for olive oil among consumers worldwide, rising from 2,544,588 tones in 2000 to an estimated 3,348,152 tones in 2021 (FAOSTAT, 2022; Guarino et al., 2014, p.1; Neves & Pires, 2018, p. 105). Currently, Spain leads the world in the production of olive oil, with 1,492,062 tonnes being produced from 2021 – 2022 (FAOSTAT, 2022). This is followed by Italy with 338,631 tones, and Greece with 293,000 tones (FAOSTAT, 2022).

However, as olive oil continues to see a greater acceptance among consumers, the growing intensification of demand has begun to place significant strain upon the market, with Mediterranean countries being unable to provide the necessary supply in a sustainable manner. Olive oil prices have risen significantly over the past decade throughout Spain, Italy, and Greece, with extra virgin olive oil rising from 189.32 euros for 100kg in 2011 to an estimated 902.5 euros in 2024 (International Olive Council, 2024). In order to try and meet this vast rise in demand, the Spanish olive oil industry has significantly transformed the longstanding agricultural practices it used to rely on, transitioning from a traditional, low intensity cropping system to what is known as intensive and super-intensive olive tree cultivation, characterized by extremely dense crop formation, as well as by integrating mechanized forms of olive grove management and water irrigation (Romero-Gamez et al. 2017, p. 25-26). Such systems have allowed for a reduction in costs by increasing the amount of olive yields per hectare of land but hold the potential for generating more adverse environmental impacts than traditional means.

GHG Emissions

One major hurdle which was encountered when conducting research into the approximate GHG emissions of the olive oil industry lies in the extremely diverse means of study employed through existing literature. Although a sizable number of studies exist that aim to analyse and discuss the various forms of GHG emissions, and the factors which contribute to them, throughout the production of olive oil, there is considerable variation in the methodology of how these studies go about this (Rapa et al., 2022, p. 654, 661-663). Existing studies employ contrasting and conflicting forms of software analysis, the confines of assessment, and analyse extremely specific areas of olive production, leaving gaps in the production of knowledge (Rapa & Ciano, 2022, p. 654, 661-663). Often, varying systems of calculation and measurement are used, such as CO2 per subsystem, SO2 per hectare, or simple percentages (Espadas-Aldana et al., 2019, p. 223). In other cases, the standard units of study also differed wildly, such as in "lbs of olives" or "Litres of oil", as did the subtypes of farms examined, for example, only organic super-intensive farms. As a result of this, there is enough research to form an appropriate answer in regard to the GHG footprint of the olive oil industry, but the following findings are not wholly conclusive given the presence of hyperspecifics (Espadas-Aldana et al., 2019, p. 223).

In their comparative assessment of various life cycle assessments surrounding olive oil production, Espadas-Aldana et al. found that, on average for cradle-to-gate studies, for every litre of extra virgin olive oil produced, approximately 1.6kg of CO2 was generated (Espadas-Aldana et al., 2019, p. 227-228). When comparing studies involving both an agricultural phase as well as an extraction phase, it appears that the process of cultivating the olives results in the greatest contribution to GHG emissions overall, these emissions largely stemming from the application of fertilizers, combustion from the use of mechanized farming equipment, and the burning of pruning materials (Camposeo et al., 2022, p. 10-15; Espadas-Aldana et al., 2019, p. 226-228;Rapa & Ciano, 2022, p. 7-9. However, when taking into account farms which employ the popular super-intensive model of cultivation, it was the use of farming equipment which resulted in greatest source of emissions (approximately 41.9%), followed by fertilizer use at 27.6% (Camposeo et al., 2022, p. 10-15). On traditional olive farms, rather than fertilizer or farming equipment, the combustion of pruning residue can be estimated to be the most influential factor contributing to GHG emissions (Camposeo et al., 2022, p. 10-15).

However, despite the sizable role held by the cultivation phase in determining the GHG footprint of olive oil production, the extraction phase also plays a key role as well, one that hinges on the system of decanting used. For the production of extra virgin olive oil, once supplied olives are crushed in order to release their oil, the olives must then be placed in either a two-phase or three-phase centrifuge (Cossu et al., 2013, p. 12; Restuccia et al., 2022, p. 1). In the Mediterranean, the three-phase system of extraction is the most commonly employed, having seen use since the 1970s (Restuccia et al., 2022, p. 2). This method of extraction is notably far less sustainable and efficient than the two-phase system but is also less costly to operate and maintain (Restuccia et al., 2022, p. 14). Importantly, the system of olive oil extraction used in processing facilities has a noticeable impact on overall GHG emissions, with Restuccia et al. (2022, p. 10) finding that while for every 1kg of oil processed, the two-phase extraction system resulted in on average about 1.13kg of CO_2 in total compared to 2.27kg of CO_2 for the three-phase system.

Environmental Impacts

In regard to the environmental impacts associated with the cultivation of olives, in the early 2000s it was noted that a strong correlation could be made between the establishment of olive groves with the emerging processes of soil erosion and desertification. Although not always an eventuality, Beaufoy (2000, p. 4) noted in their work *The Environmental Impact of Olive Production in the European Union*, that a high tendency for excessive weed control and overzealous soil management practices among European olive farmers could often exasperate the existing high risk of soil erosion present within the natural environment required for olive groves to flourish. As a result, Beaufoy (2000, p. 4) projected a growing trend of desertification spread throughout the entire European range of olive groves, a hypothesis that has not only come to pass but has in fact steadily persisted. In a 2017 study, Romero-Gamez et al. (2017, p. 26) noted high rates of desertification and soil erosion among olive groves in Spain, Greece, Portugal, and Italy, with the increased uptake of intensive and super-intensive cultivation methods being held as a likely cause. Such blame may lie in how these philosophies to olive farming approach the aspect of density within the grove itself, with both the intensive and super-intensive approach relying on a far greater number of olive trees per hectare of land in comparison to traditional methods to increase yield (Gomez et al., 2014, p. 175-176). In order to employ such high-density farming practices successfully however, the amount of fertilizer applied to the grove must be greatly intensified in comparison to traditional farms (Gomez et al., 2014, p. 175-176). Such large amounts of fertilizer are often employed alongside high rates of tillage. In conjunction with the adoption of artificial fertilizer, since the 1970s the adoption of intensive mechanized tillage has become widely utilized, especially within intensive and super-intensive systems, leading to a reduction in normally present organic materials within grove soil and allowing the eroding effect of rainfall to penetrate the aerated land (Beaufoy, 2000, p. 31-322). Furthermore, the tight grove of trees within intensive systems also serves to discourage the practice of intercropping due to the excess workload and costs associated with the maintenance of additional crops, despite the ability of intercropping to aid in improving soil stability and potentially contributing nutrients to the soil. As a result, intense and super-intensive olive groves can cause the land underneath it to transition into an overly fertilized monoculture present on unstable, degrading soil (Gomez et al., 2014, p. 175-176).

In a similar manner to that of palm oil, the production process for olive oil is also notable for resulting in a high degree of wastewater, known as olive mill wastewater (OMWW). When utilizing the more common three phase centrifuge system, processing 1000kg of olives into extra virgin olive oil results in approximately 45% of the extracted liquid being in the form of OMWW (Restuccia et al., 2022, p. 5). Mirroring that of POME, OMWW is highly acidic and contains a high quantity of organic materials. However, OMWW is especially dangerous due to possessing a wide range of heavy metals, notably among them, nickel, iron, copper, zinc, lead, and cadmium (Fleyfel et al. 2022, p. 1036-1041; Restuccia et al., 2022, p. 11). Considered one of the more toxic forms of effluent within the agro-food industry, compared to sewage, it has an estimated 200 times greater level of toxicity towards the natural environment (Fleyfel et al. 2022, p. 1041; Restuccia et al., 2022, p. 11). When untreated OMWW is applied to soil, the acidity within the mixture is known to contribute towards soil erosion while also holding the ability to reduce the growth of vegetation. These effects towards soil health and plant life are compounded by OMWW's high mineral content, which can further reduce the fertility of soil and decrease its ability to conduct water (Fleyfel et al. 2022, p. 1041). When polluting bodies of water, OMWW also contains enough occurring sugars to negatively affect the rate of dissolved oxygen in aquatic environments by affecting the microorganisms within it, reducing biodiversity (Fleyfel et al. 2022, p. 1041). At the same time, the high fat content within the wastewater can serve to form a film on top of the body of water, further blocking the rate of oxygen exposure as well as the intensity of sunlight the underwater environment may receive (Fleyfel et al. 2022, p. 1041). Complicating efforts to manage the effects of POME can be hindered by the sheer biological and chemical complexity of the substance itself, as its high amount of organic matter, metals, minerals, and fats, make it especially expensive and time consuming to process into a form that can undergo biodegradation (Restuccia et al., 2022, p. 11). As a result, although the direct disposal of raw OMWW is illegal across Spain, Italy, Greece, and Portugal, given the often complex and prohibitive nature of OWMM treatment, the effluent is commonly dumped into known waterways and into the natural environment while still untreated (Fleyfel et al. 2022, p. 1041).

Social Harms

Although the olive oil industry is built upon the contributions of multiple countries, Italy and Portugal's agricultural sectors have been noted as containing high amounts of illegally employed workers. As of 2021, Guidi and Berti (2023, p. 2) recorded that in Italy alone, 230,000 workers were illegally employed in agricultural positions. In Italy, the exploitation of migrants for labour is well known, recognized under the umbrella term of "Caporalato" which refers to illegal recruitment and exploitation. The system of "Caporalato" in Italy was argued by Jinkang (2022, p. 2, 4), in their study on the exploitation of migrant workers in Italian agriculture, to likely stem from intrinsic weaknesses within the current Italian asylum procedure, leaving migrants subject to lengthy delays within the uncertainty of migrant camps (Guidi & Berti, 2023, p. 4). Faced with an unclear future and desperate to make ends meet, many migrants in Italy are able to be pressed into exploitative employment within the agriculture sector, a similar fate shared by those trafficked into Portugal. Agricultural workers in both Italy and Portugal were found to live in highly isolated ghettos, often without necessary accommodations such as running water, toilets, electricity, and cooking areas, their movements often forcibly restricted by their employers (Jinkang, 2022, p. 5-6). In separate case studies involving interviews with migrant workers in both Italy and Portugal, workers were found to commonly not be provided formal contracts and terms of employment. If provided, such contracts were often in a language workers were not familiar with (Guidi & Berti, 2023, p. 6-7). Workers were also not informed about any benefits they may have been entitled to, such as consistent wages, fair working conditions, holidays and time off, sick leave, healthcare, and seniority (Guidi & Berti, 2023, p. 6-7; Jinkang, 2022, p. 5-6). In many cases wages not only fell below the standard for minimum wage, but often wages were withheld or significantly reduced far below what was initially promised by the employer (Guidi & Berti, 2023, p. 6-8; Jinkang, 2022, p. 5-6). Highlighting the clear imbalance and exploitation of power, many workers interviewed in both countries expressed the clear use of threats and the use of physical violence and active harm, as well as the restriction of communication to loved ones and the outside world (Guidi & Berti, 2023, p. 6-8; Jinkang, 2022, p. 5-6). For these reasons, many workers noted that although they were aware of their own exploitation, due to the fear of being arrested and deported, a lack of knowledge towards their own legal rights, a language barrier, and/or the burden of proving their own case, they withheld themselves from reporting their own mistreatment and seeking help (Guidi & Berti, 2023, p. 8; Jinkang, 2022, p. 4).

Rapeseed/Canola Oil

History and Usage

Rapeseed, known under the scientific moniker of Brassica Napus, is an oilseed crop with a far-reaching historical pedigree (Zheng & Liu, 2022, p. 157). Grown throughout Europe, Asia, and Africa for centuries in order to provide oil for a variety of applications, such as for lamps, soap, and culinary use, it has since spread internationally as a staple commercial crop present in both Canada and the United States (Canadian Food Inspection Agency, 2017; MacWilliam et al., 2016, p. 106; Zheng & Liu, 2022, p. 157). Although initially popular since the mid 1900s in North America, rapeseed oil is known to contain a high amount of erucic acid, which can cause adverse health effects if consumed in excess (Canadian Food Inspection Agency, 2017; Zheng & Liu, 2022, p. 157). To bypass this issue, a unique variety of rapeseed was developed in Canada, specially bred to contain a low amount of both erucic acid and glucosinolate (Canadian Food Inspection Agency, 2017; Zheng & Liu, 2022, p. 157). First released in 1974, canola oil (Canadian Oil), can be said to have in recent years superseded standard rapeseed oil in culinary applications due to its innately safer acid content (Canadian Food Inspection Agency, 2017; Zheng & Liu, 2022, p. 157). Although regulations may differ, in order to be considered fit for human consumption, Canadian canola oil must contain under 2% of erucic acid (Canadian Food Inspection Agency, 2017). Although not as popular as soybean or palm oil, canola oil is notable for its high yield during processing, with canola oilseeds able to produce around 45% of oil in contrast to only 20% for soy (Zheng & Liu, 2022, p. 158). In the realm of consumables, canola is a common choice in the manufacture of a variety of foodstuffs, such as shortening, margarine, spreads, and dressings, in addition to seeing use as a deep-frying oil and in baked goods (Canadian Food Inspection Agency, 2017; Zheng & Liu, 2022, p. 157-158). Aside from food products, both rapeseed and low-erucic canola oil can also be utilized in cosmetics, plastics, inks, and industrial grade lubricants (Canadian Food Inspection Agency, 2017; Zheng & Liu, 2022, p. 157-158). In recent years, rapeseed oil has been met with growing interest for use as a form of biodiesel, especially in the European market, although the industry is still emerging (Gupta et al., 2022). Given its inherent flexibility to be used in a multitude of commercial products, canola oil is now widely grown internationally in over 66 different countries as of 2020, with production increasing by an estimated 20% to 72.3 million tones between 2010-2022 (Zheng & Liu, 2022, p. 157). From 2021-2022, Canada led the world in the production of rapeseed/canola oil with 4,218,110 tones, followed by Germany with 4,013,300 tones, and China with 3,326,400 tones. In regard to the cultivation of rapeseed as a crop, Canada once again led with 32,943,049 tones being produced from 2021-2022, followed by China, India, and Australia (FAO, 2022).

GHG Emissions

Overall, in comparison to other standard oilseeds, rapeseed/canola oil produces a lower amount of GHG emissions on average throughout the life cycle, a median of 2.49kg of CO2e per kg of refined oil (Alcock et al. 2022, p. 10). Among four different studies covering the cultivation of rapeseed in France, Australia, China, and Canada, the greatest contributor to GHG emissions in all cases was found to be the production of chemical fertilizers. However, given the wide-ranging popularity of cultivating rapeseed worldwide, variations in GHG emissions and the factors which influence them can be noted depending on the country of production. In France, the production of fertilizer was found to account for approximately 44-54% of total GHG emissions, followed by the use of farm equipment, largely diesel machinery, which contributed an estimated 9-19% of emissions (Badey et al., 2013, p. 6-7). In Australia, fertilizer production resulted in 50% of all emissions, again followed by fuel consumption from agricultural machinery (around 14%) (Sevenster, 2023, p. 31). Notably, the actual application of chemical fertilizer was found to only contribute 6% of emissions (Sevenster, 2023, p. 31). In the case of China, the production of fertilizer resulted in a much greater contribution to GHG emissions, estimated to be at 60%, largely due to the use of coal for energy during the production process (Ji et al., 2021, p. 4). Rather than the consumption of fuel, instead, the application of chemical fertilizer resulted in the second highest contribution to emissions (Ji et al., 2021, p. 4). In their study into the GHG emissions associated with rapeseed cultivation in China, Ji et al. (2021, p. 6) noted that this was likely due to the widespread prevalence of over-fertilization practices among Chinese farmers, largely driven due to a lack of professional guidance in regard to proper and effective best practices towards fertilizer application. Finally, regarding Canadian GHG rapeseed/canola, in line with that of Chinese cultivation, the greatest contributor to GHG emissions was not that of fertilizer production (11-34%), but the application of fertilizer (34-64%). Following the role of fertilizer, the combustion of fuel for farm equipment was also found to be a significant source of emissions, estimated to be around 8-22% (MacWilliam et al., 2016, p. 111). Notably, current GHG results for Canadian canola are likely to be an improvement. In their study of Canadian canola production between 1990-2010, MacWilliam et al. (2016, p. 114) found that the rate of GHG emissions declined due to changes in farming and management practices, such as the implementation of conservation tillage, herbicide resistant canola, and the more restrained use of fertilizers overall. In regard to the GHG emissions associated with the production of canola oil, existing literature clearly assesses the rate of GHGs as minimal. However, Badey et al. (2013, p. 7) noted that it is highly dependent on the consumption of electricity, hence, emissions appear linked to the exact source of electricity used, such as the implementation of renewable energy.

Environmental Impacts

As described by MacWilliam et al., (2016, p. 114) one of the major sources of improved efficiency associated with the cultivation of canola can be the adoption of canola which has been genetically modified to be highly resistant to the herbicide glyphosate. While this trait is a desirable one when held by a cash crop, the unique biology of canola can lead to such a boon being hybridized and transferred to an undesired host plant, causing potentially severe harm to the balance of local ecosystems and the environment as a whole (Sohn et al., 2021, p. 1; Tobiasz-Salach, 2021, p. 76). Although canola and standard rapeseed are often intentionally constrained to farmland for cultivation, these plants hold a pervasive ability to establish themselves outside of farmed populations as weeds (Sohn et al., 2021, p. 1; Tobiasz-Salach, 2021, p. 76). The tenacity of rapeseed lies in its genetic relation to common weed species, as it is not only able to generate a high amount of pollen which is then able to be spread both through insects and on the breeze, but the crop itself has a noted ability to hybridize with other plants (Sohn et al., 2021, p. 2;T obiasz-Salach, 2021, p. 76). In addition, rapeseed can not only flourish on non-cultivated land, further enabling the plant to break containment, but also hold the ability to germinate in soil for over 5 years (Sohn et al., 2021, p. 5; Tobiasz-Salach, 2021, p. 77). In their review of known cases of GM rapeseed escapes, Sohn et al. (2021, p. 8-15) noted that examples of unintentional release could be found in Japan, the US, Canada, Switzerland, and Australia, among other countries. According to their findings, the authors noted that the "escape" of GM rapeseed could be largely traced to spillage, often from the transportation of seeds and during harvesting, with feral populations often succeeding in establishing themselves along roadsides and railway lines (Sohn et al., 2021, p. 8-16).

A significant consequence of environmental concern related to the cultivation of canola in North America is that it contributes to the drainage of key wetland ecosystems throughout the

Prairie Pothole Region (PPR). Extending through Alberta, Saskatchewan, and Manitoba, while also encompassing parts of North Dakota, South Dakota, Iowa, Minnesota, and Montana, the Prairie Pothole Region happens to coincide with many of the states and provinces holding the greatest amount of dedicated acreage for canola production (Canadian Food Inspection Agency, 2017; Muhammad et al., 2018, p. 1). Composed of unconnected wetlands which are isolated from river systems, the Prairie Pothole Region provides a host of valuable ecosystem services such as the management of groundwater and the filtration of pollutants, aiding in the storage of water during periods of drought and excess rainfall (Muhammad et al., 2018, p. 1-2). Furthermore, by providing intermittent pockets of wetland ecosystems, the PPR is able to support a wide range of wetland creatures and nesting birds, improving biodiversity (Whitfield et al., 2024, p. 5-6). In Alberta, it is estimated that nearly 90% of wetlands throughout the province have been already drained (Clare et al., 2021, p.398; Whitfield et al., 2024, p. 1). Concurrently, 2024 estimates place the amount of annual wetland losses throughout the PPR at 10,800 hectares per year (Whitfield et al., 2024, p. 1). Although this view is not exclusive to the production of canola, in their study of Albertan canola farmers, Clare et al. (2021, p. 397) found that a common narrative among farmers is that the existence of wetlands on farmland reduces the amount of available land, lowering profits, and that draining said wetlands is beneficial for business. To Clare et al., this is founded on the belief that once a wetland is drained, the land will then be able to be cultivated, as well as for a need to improve efficiency, as an existing wetland can serve as a barrier to farm equipment and increase fuel usage. As a consequence of such beliefs however, the available ecosystem services of the PPR has been found to have decreased immensely, with the noted loss of carbon stocks, hydrological systems, and a reduced ability to filter nutrients, leading to the slow buildup of pesticides and fertilizers in the natural environment (Clare et al., 2021, p.398; Whitfield et al., 2024, p. 5-6). In addition, biodiversity is also believed to have been negatively affected, with the population of wetland birds predicted to fall by 75% and overall species abundance to decline by 20-40% (Whitfield et al., 2024, p. 5-6).

Lastly, one other notable environmental harm towards the PPR linked to the cultivation of canola is the widespread use of herbicides, namely glyphosate. With the advent of herbicide resistant seed crops, such as the use of Roundup Ready Canola, high amounts of glyphosate have been detected in areas of the PPR (Malaj et al., 2020, p. 1, 5-6). In their 2016 study, McMurray et al. (p. 682, 685) investigated the occurrence of pesticides throughout 151 wetlands across North and South Dakota, finding that glyphosate not only could be found in 61% of all wetlands, but that it was far more commonly found in wetlands present nearby croplands and at a 4 times greater concentration.

Social Harms

With Canada being the largest producer of both canola and canola oil, one major potential source of worker inequality tied to the crop may be the government led Temporary Foreign Worker program. Defined by the Canadian government as a program allowing "employers to bring foreign workers to Canada on a temporary basis to fill jobs for which qualified Canadians are not available.", the TFW was first enacted in 1973 and has seen multiple revisions and expansions throughout the last few decades (Omidvar & Cordy, 2024, p. 9). Currently, it remains a highly utilized program among businesses, with an estimated 70,267 temporary foreign workers approved to work in Canada's agricultural sector in 2023, of them, 1,620 for oilseed and grain farming and 387 in oilseed milling (Statistics Canada, 2024). However, considerable criticism has also emerged that frames the TFW system as one that disproportionately favours employers. In the senate report *"Act Now: Solutions for Temporary and Migrant Labour in Canada",* the Standing Senate Committee on Social Affairs, Science and Technology found that, according to testimony and submissions from migrant workers within the TFW program, that many workers feel that the current TFW system works to stifle their rights and limit their fundamental freedoms. Workers are often bound by closed, employer-specific contracts, preventing them seeking fair or more competitive placements elsewhere, forcing them to only stay with their assigned employer and incentivising them to raise not any objections or concerns (Omidvar & Cordy, 2024, p. 34). The ability of workers to air concerns and confront any existing or potential labour violations is also limited by the ability of employers to terminate one's position without providing a grievance procedure for fired employees, allowing the potential for "disorderly" workers to face repatriation without any form of defence (Omidvar & Cordy, 2024, p. 35-36). Although the Canadian Government has taken some measures to mitigate such potential forms of worker inequality through the creation of open work permits for workers who happen to be the victims of abuse, the open work permit system itself is highly flawed. In order to quality for transfer under the open work permit system, workers are to provide their own evidence, potentially including "medical information, victim impact statements, copies of communications, and photos showing injuries or working conditions." (Omidvar & Cordy, 2024, p. 40). The submission process is also flawed, requiring workers to have experience with the French language, access to a computer, and knowledge of complicated programs such as excel and adobe acrobat, in addition to large time and labour investments (Omidvar & Cordy, 2024, p. 401). Ultimately, although oilseed production and milling roles only take up a smaller portion of workers with the TFW program, the potential does exist for them to face significant rights violations and inequality while connected to the production of Canola oil, a possibility that must be recognized.

Soybean Oil

History and Usage

In tracing the history of the soybean, the crop is likely a descendant of an ancient legume known as G. Soja (Canadian Food Inspection Agency, 2021). Believed to have been domesticated as far back as 9,000 years ago in China, the soybean eventually found its way to both Europe and North America in the 1700s, before being introduced to the lower Americas in the 1900s (Canadian Food Inspection Agency, 2021). A crop best grown in the warmer months, the modern soybean is largely cultivated in the North and South Americas, with Brazil leading as the global supplier with 33% of total production, followed by the United States (28%) and Argentina (16%) (Dreoni et al., 2022, p. 2). These three major producers are estimated to provide nearly 77-80% of all soybeans worldwide (Sedibe et al., 2023, p. 2). Although soybeans have a wide range of applications, from the plant-based products of soy milk and tofu to the production of soybean meal for livestock, as of 2023, soybean oil is the second most widely consumed vegetable oil in the world, only behind that of palm oil (Sedibe et al., 2023, p. 2-4). In the same vein as palm oil, soybean oil has seen a significant rise in popularity in the past few decades, with demand estimated to have increased by about 116% from 2000 to 2022 (FAO, 2022, p. 10). In the case of the cultivation of soybeans, a similar meteoric rise can be observed. In Brazil, the total amount of land used for the cultivation of soy is estimated to have grown from 9,742.50 hectares in 1990 to 33,176.90 hectares in 2015, nearly quadrupling in area (Amaral et al., 2021, p. 1296). A large portion of the soybean's success, and that of soybean oil, can be attributed to the creation and widespread adoption of genetically modified soy, specifically those that are engineered to hold a higher rate of herbicide resistance (Sedibe et al., 2023, p. 2). As of 2023, an estimated 80% of soybean cultivars in use worldwide are genetically modified, most notably being the roundup ready variety of soy produced under the Monsanto brand (Sedibe et al., 2023, p. 2).

GHG Emissions

Across the chain of production, refined soybean oil was found to have a median GHG emission of 4.25kg of CO_2e per kg of oil (Alcock et al., 2022, p. 9). However, when determining the most significant contributing factors which served to influence the GHG footprint of soybean oil, differences emerged depending on the area of production. Ultimately, a large amount of variability exists regarding the GHG emissions associated with soy due to site specific changes in land use practices and transportation needs. In the case of soybeans cultivated in Brazil, the greatest contributor to GHG emissions was the presence of land use change through the act of deforestation (Escobar et al., 2020, p. 6-7). In their study of the potential GHG footprints of soybean producing municipalities throughout Brazil, Escobar et al. (2020, p. 6-7) found that the greatest emissions could be found in municipalities located within the main agricultural LUC frontiers within the Amazon and Cerrado, where large scale deforestation is used to produce new agricultural land for farming. Following the contributions of LUC, Escobar et al. found that the second major contributor the GHG footprint of Brazilian soy was the role of transportation. Differing from the cultivation of other oilseeds, the domestic transport of soybeans accounted for nearly a quarter of emissions, largely due to the country's reliance on road infrastructure to reach the soybean plantations located deep within the now deforested wilderness (Escobar et al., 2020, p. 6-7). Overall, Escobar et al. (2020, p. 6-7) noted that when sourcing soy from the Cerrado in comparison to less landlocked areas of Brazil, more than 2.7 to 3.3 times greater CO_2 emissions were produced on average.

In regard to soybeans cultivated in the United States, the vast majority of GHG emissions can be found to stem from the cultivation phase, estimated to consist of 54% in total (Sustainable Solutions, 2024, p. 20-24). Of the cultivation phase, similar to that of Brazil, the greatest contributor to emissions could be traced to LUC, largely through the conversion of grasslands, and the use of farm equipment utilizing diesel fuel. This is followed by the application of fertilizers and herbicides (Sustainable Solutions, 2024, p. 20-24). Following the cultivation phase, 21% of emissions result from the crushing and degumming process required to convert soybeans into crude soybean oil, however, this is dependent on the fuel sources used (Sustainable Solutions, 2024, p. 36). In the 2024 life cycle assessment into the sustainability of soybean oil by the Sustainable Solutions Corporation (p. 36, 40-45), they noted that the most commonly used fuel sources for the soybean oil processing phase was mainly natural gas and coal. Once processed, the crude soybean oil is then transported to a final processing plant to undergo refinement into refined soybean oil. The prior life cycle assessment noted that further GHG emissions were produced through the fuel consumed when transporting the soybeans, as well as through the further consumption of coal, natural gas, and electricity at the refining plant (Sustainable Solutions, 2024, p. 36, 40-45). Of importance, is the fact that it was found that this 2024 life cycle assessment identified that between 2015 and 2024, the overall amount of GHG emissions produced throughout the soybean oil refining pipeline had decreased slightly, a change attributed to more efficient farming practices and equipment, while the use of natural gas had increased (Sustainable Solutions, 2024, p. 36, 64).

Environmental Impacts

When discussing the environmental impact caused by the production of soybean oil, the most significant consequence can be traced to the deforestation and land use change occurring in Brazil, Argentina, and the United States, spurred by the cultivation of soybeans. For South America, a variety of countermeasures exist which aim to minimize or mitigate the effects of continued soybean expansion into forested land, the most well known among them being the Amazon Soy Moratorium. First introduced in 2006 by companies associated with both the Brazilian Association of Vegetable Oil Industries and the National Association of Grain Exporters, the soy moratorium was founded with the purpose of mitigating soybean farming in deforested areas (Amaral et al., 2021, p. 1296). It aims to achieve this by discouraging the purchase of soybeans from producers known to cultivate soy linked to deforestation through the use of remote sensing (Amaral et al., 2021, p. 1296).

Among the three major producers of soy, although the effects of LUC are significant in all cases, it is Brazil that bears the greatest biological harms of soybean cultivation though the large-scale conversion of the Cerrado biome. The Cerrado is a savanna biome which is known to provide several vital ecosystem services to the surrounding area, such as the provision of carbon via carbon storage, climate regulation, and the regulation and circulation of fresh water towards both native rivers and underground aquifiers, all through the contribution of its exceptional system of deep-rooted vegetation (Aragao, 2022, p. 1, 3; Dijkhorst et al., 2018, 1-2; Lahsen et al., 2016, p. 6-8). Ultimately, the Cerrado is believed to supply an estimated 70% of water to 8 of the 12 hydrographic regions of Brazil (Dijkhorst et al., 2018, 1-2; Lahsen et al., 2016, p. 6-8). Despite its high environmental importance, the expansion of soy cultivation throughout the region has led to the slow erosion of the Cerrado's vegetation. Between 2000 and 2017, approximately 7.5 million hectares of land within the Cerrado were converted into farmland for cultivating soy, now providing an estimated 50% of all farmland for soy throughout Brazil (Dijkhorst et al., 2018, p. 3). This is largely due to the Cerrado's largely unprotected status in comparison to the Amazon, with only 8.3% of the Cerrado being protected land in 2015 (Aragao, 2022, p. 1, 3; Lahsen et al., 2016, p. 8). In addition, law in Brazil requires landowners to conserve only about 20-35 % of native forest within the Cerrado, in comparison to 80% within the Amazon (Aragao, 2022, p. 1, 3). A similar story can be found within Argentina, as from the 1970's onward, soybean production has been found to have greatly expanded into the northern Chaco region, one of the largest forests in South America. Between 1972 and 2011, Leguizamon noted that an estimated 2.7 million hectares of the Argentinian Chaco were deforested, while, concurrently, Giorgio et al. (2022, p. 69) found that the amount of land utilized for soybean cultivation expanded by a rate of 308% (Leguizamon, 2016, p. 867).

Concerningly, it is not just South America that is vulnerable to soybean spurred land use change, in the soybean producing areas of the United States, a mirrored transition of land has occurred in tandem. In the case of the US, soybean is grown in a paired process with Corn to form a soybean-corn cropping system (Wright and Wimberly, 2013, p. 4134). Largely produced in a geographical tract known as the US Corn Belt, Wright and Wimberly (p. 4135-4136) found in their 2013 study that a wide range of grassland throughout the Corn Belt in North and South Dakota, Minnesota, Iowa, and Nebraska was widely converted to Corn/Soybean cropland between 2006 to 2011 at a rate between 5-30 each year. Likely driven by the high price of both corn and soybeans as well as the financial incentives provided by government cropland insurance, Wright and Wimberly (2013, p. 4135-4136) concluded that such widespread expansion would greatly affect the rate of biodiversity among nesting grassland bird populations across the Corn Belt, a population already on the decline. In addition to the conversion of grassland releasing a high amount of sequestered CO2, as of 2013, temperate grassland was noted to be a biome already in transition worldwide and among those with the least amount of environmental protection (Wright and Wimberly, 2013, p. 4134-4138).

Regarding pollution associated with the cultivation of soy and the production of soybean oil, a key pollutant is that of glyphosate. Developed by Monsanto with the title of "Roundup", glyphosate is a non-selective herbicide used to control the spread of weeds on cropland (Leguizamon, 2016, p. 688). With the widespread adoption of GMO glyphosate resistant soybeans, Monsanto's brand being the "Roundup Ready" variation, farmers have since been able to apply vast amounts of pesticide without fear of damaging their own produce. In Argentina, the use of glyphosate among farmers rose from an estimated 821,000 kilograms in 1996, when 6% of soybeans in use could be considered GMO, to an estimated 88,000,000 kilograms in 2014 (Leguizamon, 2016, p. 688). While the allowance of such liberal glyphosate application has proven beneficial for curtailing weed growth and ensuring higher yields, it has also contributed to a unique form of pesticide contamination and saturation into the natural environment. The reason for this partially lies in what has become known as the "pesticide treadmill", in which the continuous application of glyphosate has led to the emergence of glyphosate resistant weeds which then require higher rates of glyphosate to kill, leading to even more resistant weeds and giving birth to a vicious cycle (Leguizamon, 2016, p. 688).

In addition to the creation of extreme resistance weeds, the high volumes of pesticides involved in the cultivation of GMO soy can lead to them spreading throughout and damaging the environment surrounding farming areas. In their research into soil studies throughout the Brazilian Cerrado, Hunke et al. (2014, p. 1154, 1168) found that pesticides could be detected in water samples throughout the entire aquatic system of the biome, with peak concentrations vastly exceeding the safe limits set out in both the European Union and Brazilian water quality standards. Among all soil studies they consulted, each one noted clear traces of contamination in surface water, groundwater, and rainwater, highlighting the potential for pesticides to further leach into the environment (Hunke et al., 2014, p. 1154, 1168). Furthermore, in addition to the risk of contamination, pesticides and glyphosate can be noted to pose a high risk towards the wellbeing and stability of affected plant life. In a simulated study, Florencia et al. gathered 20 different plant species collected within the South

American Chaco and subjected them to sprays of glyphosate to determine the potential for negative effects resulting from exposure. By the end of the experiment, they noted that lethal and sublethal damage could be observed, even when only 25% of the recommended field application rate of glyphosate was applied (Florencia et al., 2017, p. 362-365). Concerningly, such a hypothetical situation of exposure is quite possible, as through the drifting of pesticide sprays during application and overspraying, pesticides can come into contact with non-target organisms and plants as far as 2 miles away, and, in rare cases, up to 10 miles (Florencia et al., 2017, p. 366).

Social Harms

Across Brazil and Argentina, studies have highlighted a consistently prevalent system of land appropriation, displacement, and violence, targeting indigenous populations and smallholder farms . Although not fully tied to the largescale production and cultivation of soybeans, and such occurrences are endemic to the agricultural sector within these countries as a whole, such forms of domination and oppression have seen use within major areas in which the cultivation of soy is vital (Dreoni et al., 2022, p. 7). In their 2020 work, Vellejos et al. (p. 4-6) describe how land use conflicts related to agricultural expansion within the Chaco and Cerrado have been marked by the "presence of large-scale producers with legal title to the land, and small peasant units with insecure forms of tenure based on customary rights". Such a discrepancy, the conflict between traditional, often informal rights to land, and more formal systems of deeds and databases, can lead to the practice of land grabbing for the purpose of securing what is seen as "unutilized" prime agricultural land through "legal means" that do not include the fair participation of indigenous and peasant communities (Vellejos et al., 2020, p. 5-6). In the face of such conflict, multiple coercive strategies are used to pressure communities and smallholders into giving up their land for agricultural use, such as offering payment (often far below the fair value of the land itself), the implementation of forced deforestation surrounding the land, blockading roads and water sources, to even documented cases of murder and arson (Lende & Velazquez, 2018, p. 124; Busscher et al., 2020, 505-508, 512-515). Notably, in Giorgio et al.'s (2022, p. 74-75) study into Argentinian peasants and the ownership of land, they found that external actors also served to capitalize on the high rate of illiteracy among landowners to present land use transfer contracts under false pretenses. The use of isolation was also applied, with fences being erected in the vicinity of households and their land, as well as the use of threats and physical violence to cultivate an environment of fear, thus spurring existing landowners to move (Giorgio et al., 2022, p. 74-75). Ultimately, such tactics have proven successful, with Giorgio et al. (2022, p. 75) noting that, on average, only 22% of surveyed peasant households within the Pellegrini region of the Argentinian Chaco held a property title for their land. Similar findings were found in Lende and Valquez's (p. 122) 2018 work, which concluded that 70% of all agricultural land within Argentina has already been leased to external actors, with local actors losing all control over the agricultural practices involving their land.

Findings and Analysis

In assessing the findings of my research into the social and environmental sustainability of the plant-based oil industry, a number of trends can be seen across the spectrum of popular oilseeds selected for review. Regarding the myriad of environmental issues found to result from the cultivation and production of plant-based oils, perhaps the most prominent trend which can be identified is the consistent role of land use change. Although the manner and methodology behind the practice of land use change differed among the oilseeds, it nevertheless was present, taking the form of deforestation for palm and soy, the drainage and clearing of wetlands for canola, and the desertification process for olive oil. No matter the form, LUC was found to often contribute to a significant increase in the amount of GHG emissions associated with the cultivation phase through the removal of carbon sinks and/or a drastic loss in ecosystem services and biodiversity. A second notable environmental trend among all oilseeds was the environmental consequences associated with the use of synthetic fertilizer and pesticides. In the case of synthetic fertilizer, the production and application of fertilizer was commonly recorded as contributing heavily to GHG emissions, only second to that of land use change if deforestation was present, notably highlighted in the case of olive oil and canola oil. This can be attributed to the non-renewable energy mix utilized in the production of synthetic fertilizers, as well as the release of GHGs following application. The high rates of GHG emissions from fertilizer can also potentially be caused by a lack of efficient application standards, as the cultivation of Chinese rapeseed highlights the possible presence of over-fertilization among farmers due to the absence of common knowledge towards best practices. The application of pesticides was found to be a common thread towards pollution in the case of soybean and canola oil, both cases being notable for involving the documented spread and buildup of glyphosate into the nearby environment and throughout hydrological systems. Of note is the fact that for both canola and soybean, the use of herbicide resistant GMO variants may have likely contributed to the overly excessive application of pesticide and further led to the spread of resistant weeds, highlighting the need for a more targeted, restrained approach in order to minimize their associated environmental harms.

Another notable trend can be seen in that the production of olive oil and palm oil both involve the production of a waste product that is currently processed in a suboptimal way, palm oil mill effluent (POME) in the case of palm oil and olive mill waste water (OMWW) for olive oil. In the case of POME, due to issues of cost, it is near universally processed using an open pond system, despite the significant reduction in GHG emissions associated with a closed pond system. OMWW results from a similar conflict. Although two phase centrifuge systems are able to result in a vastly reduced amount of POME by increasing olive oil production efficiency, the cost associated with switching from a three phase to two phase system is considered prohibitive to producers. Furthermore, both forms of oil wastewater are commonly disposed improperly out of convenience, leading to the direct pollution of waterways and bodies of water. Lastly, although it may hold a minor influence in comparison to the more drastic environmental harms discussed, the presence of diesel-powered farm equipment is constant across all oilseeds, leading to a noticeable contribution to GHG emissions, albeit on a small scale.

In regard to trends involving social harms, it can be argued that the systems of labour surrounding the most popular oilseeds may be largely dependent on worker exploitation. Across all investigated oilseeds, save perhaps for the lack of concrete evidence surrounding canola cultivation, the clear presence of multiple forms of human rights infringement were recorded. Oil palm and olive plantations were found to employ high amounts of forced labour, relying on a constant supply of migrant workers, both legal and illegal, who are then stripped of their rights and freedoms. The use of unclear or false conditions and terms of employment were commonly utilized as a means of stifling the rights of workers to time off, sick leave, and fair wages (if any). The use of ghettoization was also notably seen, restricting the ability of workers to contact the outside world and seek assistance, often coupled with the use of coercive threats, violence, and debt bondage, among other measures. The explicit use of child labour, and the disenfranchisement of female workers is also notable. Outside the realm of labour, another major similarity shared between the production of soybeans and oil palm is a clear lack of fair representation and participation involving land use change. In Malaysia and Indonesia, where palm oil is grown, this is expressed through the often exclusionary and unstandardized system of sustainable impact assessments conducted by plantation owners and businesses in which affected local populations and workers are often passed over for consultation in the name of efficiency or due to a lack of knowledge on behalf of who to consider as valid stakeholders. Importantly, this was also found to lead to a significant lack of representation from women and indigenous groups. In the case of soybean oil, a lack of fair representation and participation can be seen through the prevalence of land grabbing as a means of control and repression. Given the value associated to uncultivated land, the soybean industry in Brazil and Argentina can be seen to be rife with the exploitation of peasant and indigenous populations, relying on coercive means and exclusionary practices to secure additional land for expansion at the lowest possible cost. This can be said to have resulted in the rapid disenfranchisement of poor farmers and indigenous groups, as the continued theft and procurement of their land titles has left them largely powerless towards how their land and environment is used. Overall, these findings paint a concerning picture, grounding the current role of corporate purpose within the oilseed industry as being largely unconcerned with the environmental and social welfare it holds influence over.

Mitigation Methods – A Guide for Businesses

Although the current reality of the plant-based oil industry is rife with environmental and socioeconomic injustice, there are a number of potential mitigation strategies which large companies can and should use to capitalize on their ability as influential changemakers. It can be argued that there is a vast opportunity for improving the environmental sustainability of the entire industry, as well as to significantly overhaul the proper treatment of workers at the bottom of the supply chain.

Broad Mitigation Methods

Reduce Emissions from Synthetic Fertilizer

As seen throughout my analysis of soy, palm, olive, and canola oil, the production and application of synthetic fertilizer was found to be major source of GHG emissions, often second to only that of emissions involving significant deforestation. One method of attempting to limit the overall GHG emissions associated with oilseed crop production could be working to lower the GHG footprint of synthetic fertilizer from both the perspective of production and application. In the case of production, Gao & Serrenho (2023, p. 5-6) document that the process of creating fertilizer via the Haber-Bosch process is largely dependent on the consumption of fossil fuels. Specifically, they argue that the separation of nitrogen, the process of water electrolysis, and the generation of heat, all key steps in the creation of synthetic fertilizer, could likely be replaced with electricity produced from renewable sources, leading to meaningful reductions in CO2, N2O and CH4 (Gao & Serrenho, 2023, p. 5-6).

In conjunction with addressing emissions regarding the production of fertilizer, a second method of attack would be to lower the rate of fertilizer use by aiming to improve the efficiency of application. In their study of nitrogen fertilizer and how application methods can differ around the world, Martinez-Dalmau & Berbel (2021, p. 1-2, 6) draw upon the concept of nitrogen use efficiency (NUE), a term referring to the ability of crops to draw upon the nutrients provided to them. In their analysis, they note that the rate of NUE is likely around 43-55% worldwide, highlighting a need for a greater improvement in the application, timing, and methodology of fertilizer use throughout agriculture (Martínez-Dalmau et al., 2021, p. 1-2, 6). Although such an upheaval may appear daunting, examples exist of such change being possible. In a decade long experiment, Cui et al., used a network of agribusiness workers and support personal to engage with farmers across China with the goal of increasing education regarding more efficient farming practices. By the end of the 10-year study, they noted that, among other benefits, the application of nitrogen fertilizer decreased by approximately 14.7-18.1%, translating to a reduction of about 1.2 million tonnes (Cui et al., 2018, p.

363-366). Drawing upon these findings, businesses within the oilseed industry should aim to invest in smallholder education, perhaps partnering with NGOs to establish an accessible, easy to understand, and community driven system of outreach that highlights the economic and environmental benefits of managing fertilizer application, as well as describing the proper procedure (Cui et al., 2018, p. 367).

Establishing Clear Limits on Deforestation and Meaningful Penalties

As previously discussed, deforestation and land use change associated with the cultivation of oilseed crops can be traced to extremely elevated levels of GHG emissions through the removal of carbon sinks as well as severe losses in both ecosystem services and environmental biodiversity as a whole. Although current methods at curbing such widespread LUC, such as the well meaning efforts of the Roundtable on Sustainable Palm Oil and the Soy Moratorium, clear gaps in their ability accurately monitor and identify cases of LUC and their failure in assigning clear penalties to those who breach their codes of conduct. This leaves the current state of deforestation measures largely performative in nature. Although nothing can be done to reverse cases of deforestation that have already occurred, businesses that truly do wish to curb the drastic effects of land use change should seek to form a united front in excluding plantations with known ties to maintained LUC while also serving to close existing loopholes allowing the relabelling of deforested land. Although enacting such a proposition alone may likely be a far easier and less time-consuming proposal, the absence of a united front would simply allow the continued presence of deforestation by enabling offenders to receive support from non-participants. Such a system should also be backed up by severe penalties, such as fines or outright exclusion, to ensure that the potential benefits of deforestation for landowners do not overcome the consequences of their actions. In the case of smallholder deforestation, Zhunusova et al. (2022, p. 4-6) argue that committing to a 100% deforestation free supply chain would likely prove to be highly exclusionary for smallholders by placing the onus of sustainability on those who cannot afford such change. To address this, I propose that large businesses in the oilseed sector, or who rely on plant-based oils, should aim to provide financial incentives for smallholders to enact more sustainable practices, such as paying a premium to farmers that avoid deforestation and land clearing. Although relying on "feel-good" messaging about the importance of the environment and conservation may make for good publicity, in their study of soy farmers in the Cerrado, Aragao (2022, p. 4) noted that in many cases, motivating smallholders using purely a sustainability centered rationale, such as sustainability certifications, did not result in meaningful change to farming practices, likely due to the prohibitive costs associated with them.

Worker Rights and Labour

In the same manner as for preventing deforestation and land-use change, I recommend that the companies take a proactive approach and form united, standardized system of enshrining workers rights. Businesses should prohibit working with plantations that have exhibited past examples of forced labour, worker exploitation, child labour, and other labour violations. To ensure that current cases of labour violations are caught, perhaps contacting a third-party NGO or organization for support, unprovoked surprise, in person, audits of plantation spaces and working conditions should be carried out alongside regularly scheduled inspections to reduce the chance of evidence being hidden in advance. In addition, top-down communication and survey methods should be provided to employees that bypass plantation overseers, providing a separate, private channel for grievances to be heard. At the same time, businesses should ensure that all employees are provided with legible contracts in their respective language, with clearly defined terms and conditions to their employment, and which outline the rights and freedoms they are entitled to. In addition, businesses should work to actively support local smallholders by assisting them in formally documenting their own right to land ownership. As the process of certifying a land claim is likely prohibitive to indigenous groups and farmers due to issues of cost and accessibility, especially given their rural location, facilitating the land claim process could help prevent land grabbing (Zhunusova et al., 2022, p. 6).

Oil Specific Mitigation Methods

<u>Palm Oil</u>

Aside from major reductions in the rate of deforestation and land use change, one major area of environmental mitigation exclusive to palm oil production would be targeted improvements in the fermentation and disposal process for POME. As discussed, POME was found to contribute to nearly a quarter of all GHG emissions associated with palm oil due to the widespread implementation of open pond fermentation systems. This impact could be mitigated however by either investing in closed pond systems or utilizing the capture of POME biogases, preventing the emissions produced through fermentation from being emitted into the atmosphere, potentially reducing the GHG footprint of palm oil by up to 0,95t of CO_2e per t of crude palm oil (Hosseini & Wahid, 2015, p. 777; Lam et al, 2019, p. 833). Given the high financial barrier to installing such equipment, with currently around 85% of palm oil producers utilizing the cheaper open pond system, businesses should take the initiative and ideally provide some form of financial support or incentive for their suppliers to assist them to make the shift, prevent years of future emissions. Businesses should also consider putting stricter standards in place regarding the improper disposal of POME, given the tendency for untreated POME to be pumped into the natural environment as a cost-cutting and time-saving measure.

Olive Oil

In the same vein as seeking to upgrade POME fermentation methods, businesses should ideally aim to either source their olive oil to producers utilizing a two-phase centrifuge process in order to minimize the production of olive oil mill wastewater, or, more ideally, aid their suppliers in transitioning to this more efficient system (Restuccia et al., 2022, p. 5, 7, 12-13). Further regarding waste products, olive pomace generated during the extraction process, if treated properly, may be mixed with manure to form compost, lending a second life to what may ordinarily be categorized as an undesirable byproduct (Cossu et al., 2013, p. 18; Espadas-Aldana et al., 2019, p. 227). On the topic of desertification, which notably was found to be a major long-term consequence of improper soil management and fertilizer use within olive groves, businesses should explore the use of cover crops. In their analysis of Andalusian olive groves, Gomez et al. (2014, p. 180, 183-184, 193) found that the use of cover crops greatly reduced the progress of erosion while also serving to improve the overall quality of the soil. If used alongside the efficient application of fertilizer, these two practices could serve to reduce the rate of biodiversity loss and desertification associated with modern intensive olive cultivation strategies.

Soybean Oil

In the case of soybean oil, one method of mitigation could be the integration of perennial vegetation alongside cropland as a means of reducing the effects of widespread monoculture plantations on the cohesion of the natural environment. One method to achieve this could be the application of prairie strips, which has seen some success in the United States. In their study into the efficiency of prairie strips as a means of restoring biodiversity and ecosystem services, Schulte et al. (2017, p. 11247-11250) found that the practice worked to foster carbon storage, improve soil and water quality, and a greater abundance of pollinators and bird species, among other benefits. Given the large investment of both time and money required to set up a prairie strip, notwithstanding the reduction in cropland it occupies, businesses may be able to encourage the use of prairie strips through financial incentives or NGO partnerships.

Canola Oil

Regarding canola oil, an area of interest for mitigation is the preservation of existing wetlands within the Prairie Pothole Region. As mentioned, Clare et al. (2021) highlighted in their research that a likely reason for the continued drainage of wetlands on farmland is due to the perception that such land is an economic drain on farmers, preventing the growth of additional crops. Although working to provide increased awareness among farmers about the beneficial environmental effects of wetlands may serve to decrease the potential for further drainage, a more direct option for businesses may be available through collaborative wetlands restoration. An example of this can be seen through the Government of Ontario's recent announcement in 2020 of the Wetlands Conservation Partner Program, in which funding and support is provided to various NGOs working to restore and maintain wetlands around the province, including those on agricultural land (Government of Ontario, 2024).

The Role of Government in Fostering Mitigation

Lastly, it is important to consider that despite the vast influence that businesses within the oilseeds sector may hold towards improving the socioenvironmental impact of the industry, expecting such positive change is unrealistically optimistic. Putting the previously outlined mitigation strategies in place will require a significant investment of capital, time, and human resources in order to bring them to fruition in a manner that is effective, efficient, and meaningful. For many companies, even those who have moved away from shareholderism towards a more holistic stakeholder focused mindset, pursuing such practices will likely be viewed as an unnecessary or excessive use of company resources that detracts from the stability of their bottom line. In the rare case that such mitigation efforts are enacted, they may be reduced in scale and scope, subject to poor documentation, and/or be held to standards and goals which are not truly binding. For these reasons, the role of corporate changemaker may be best held by the governments of oilseed producing countries, with the rule of law ensuring that businesses within the oilseed sector are held to account for their actions. Given the relative monopoly that countries such as Indonesia, Malaysia, Brazil, and Spain, hold on the cultivation of specific oilseeds, pressure could be exerted on companies operating within these countries by way of threatening exclusion unless specific socioenvironmental criteria are met. One possible inspiration for such regulations could be the EU's recent acceptance of the "European Sustainability Reporting Standards", which requires all large and listed companies to disclose a standardized report highlighting their own social and environmental risks, impacts, and opportunities (European Commission, 2023). Such a methodology would help prevent the omission of negative externalities by businesses, as well as not only highlight areas of potential improvement but draw attention to businesses which fail to act upon them, damaging their image. This could likely work in conjunction with a second EU policy, the "Directive on Corporate Sustainability Due Diligence", which sets a standardized framework which requires companies to identify and address human rights and environmental liabilities within their operations, supply chain, and among business partners, a process which is supervised and enforced (European Commission, 2024). If the governments of oilseed producing countries choose to adopt such policies, albeit on a far smaller and more manageable scale, perhaps they could serve to spur the socioenvironmental change the industry requires to meet demand in a sustainable manner.

Conclusion

From the dominant, profit-focused mentality of shareholderism popularized by Milton Friedman to the modern emergence of corporate social responsibility and ESG, the perceived role of business in society can be said to have undergone a slow yet seismic shift in the last 50 years. With the drastic consequences of climate change and global inequality being made startlingly clear, a new era is approaching in which businesses are not only held to far more stringent socioenvironmental standards but expected to contribute towards furthering them. In the global oilseeds industry, vital to supplying the world with a necessary supply of dietary fats and commercial products, a startling lack of such corporate responsibility appears widespread and largely accepted as commonplace behaviour. With demand expected to sharply increase in the coming year, the current state of the industry can already be considered to be wholly unsustainable, with current business practices enabling immense amounts of deforestation and land use change, high rates of pollution from the excessive application of pesticides and fertilizer, large declines in both biodiversity and ecosystem services, and surprisingly high contributions to global GHG emissions. Concerningly, the harms associated with the plant-based oil industry is not only limited to being environmental in nature, with my analysis uncovering that the industry is largely founded on the exploitation of forced and child labour, employee disenfranchisement, and the exclusion and disempowerment of indigenous groups, smallholders, and villages. Addressing such deep-rooted facets of the industry will not be easy, and will require that businesses truly step up to the task. By taking steps to ban the continued presence of deforestation, reduce the incentive of land use change, provide more efficient, accessible, and sustainable forms of fertilizer use, and holding responsibility for the rights and freedoms of plantation workers and farmers, I am hopeful that change can be possible. Ultimately, the role of business is one that is uniquely suited to reshape the world. That said, to be truly successful, not just in this day and age but in the years to come, the plant-based oil sector must reshape itself so that the needs of both current and future generations are taken into account.

References

Abrudan, L. C., Matei, M-C., & Abrudan, M-M. (2021). Towards Sustainable Finance: Conceptualizing Future Generations as Stakeholders. *Sustainability.* https://doi.org/10.3390/su132413717

Acobta, A. N., Ayompe, L. M., Wandum, L. M., Tambasi, E. E., Muyuka, D. S., & Egoh, B. N. (2023). Greenhouse gas emissions along the value chain in palm oil producing systems: A case study of Cameroon. *Cleaner and Circular Bioeconomy,* https://doi.org/10.1016/j.clcb.2023.100057

Alcock, T, D., Salt, D, E., Wilson, P., & Ramsden, S, J. (2022). More sustainable vegetable oil: Balancing productivity with carbon storage opportunities. *Science of the Total Environment.* 1-14. http://dx.doi.org/10.1016/j.scitotenv.2022.154539

Alfy, A. E., Palaschuk, N., El-Bassiouny, D., Wilson J., & Weber, O. (2020). Scoping the Evolution of Corporate Social Responsibility (CSR) Research in the Sustainable Development Goals (SDGs) Era. *Sustainability. doi:10.3390/su12145544*

Amaral, D. F., Filho, J. B D. S. F., Chagas, A. L. S., & Adami, M. (2021). Expansion of soybean farming into deforested areas in the amazon biome: the role and impact of the soy moratorium. *Sustainability Science.* 1295-1312. https://doi.org/10.1007/s11625-021-00942-x

Badey, L., Lahitte, N., Flenet, F., & Bosque, F. (2013). French environmental communication on sunflower and rapeseed oils based on life cycle assessment. *Oilseeds & Fats - Crops and Lipids.* 20(4). DOI: 10.1051/ocl/2013004

Bajzelj, B., Laguzzi, F., & Roos, E. (2021). The role of fats in the transition to sustainable diets. *Lancet Planetary Health.* 644-653. https://doi.org/10.1016/S2542-5196(21)00194-7

Bausano, G., Masiero, M., Migliavacca, M., Pettenella, D., & Rougieux, P. (2023). Food, biofuels or cosmetics? Land-use, deforestation and CO2 emissions embodied in the palm oil consumption of four European countries: a biophysical accounting approach. *Agricultural and Food Economics*. 11(35). https://doi.org/10.1186/s40100-023-00268-5

Beaufoy G. (2000). The environmental impact of olive oil production in the European Union : practical options for improving the environmental impact : final report. *European Forum for Nature Conservation and Pastoralism.*

Busscher, N. Parra, C., & Vanclay, F. (2020). Environmental justice implications of land grabbing for industrial agriculture and forestry in Argentina. *Journal of Environmental Planning and Management*. 63:3. 500-522. https://doi.org/10.1080/09640568.2019.1595546

Camposeo, S., Vivaldi, G. A., Russo, G., & Melucci, F. M. (2022). Intensification in Olive Growing Reduces Global Warming Potential under Both Integrated and Organic Farming. *Sustainability. https://doi.org/10.3390/su14116389*

Canadian Food Inspection Agency. (2017, December 22). *The Biology of Brassica napus L. (Canola/Rapeseed).* canada.ca, https://inspection.canada.ca/en/plant-varieties/plants-novel-traits/applicants/directive-94-08/biology-documents/brassica-napus

Canadian Food Inspection Agency. (2021, June 15). *The Biology of Glycine max (L.) Merr. (Soybean).* canada.ca, https://inspection.canada.ca/en/plant-varieties/plants-novel-traits/applicants/directive-94-08/biology-documents/glycine-max-merr

Cerone, M. & Smith, T. K. (2021) A brief journey into the history of and future sources and uses of fatty acids. *Frontiers in Nutrition*. doi: 10.3389/fnut.2021.570401

Clare, S., Danielson, B., Koenig, S., Pattison-Williams, J. K. (2021). Does drainage pay? Quantifying agricultural profitability associated with wetland drainage practices and canola production in Alberta. *Wetlands Ecology Management.* 397-415. https://doi.org/10.1007/s11273-021-09790-z

Cooper, H. V., Evers, S., Aplin, P., Crout, N., Dahalan, M. P. B., & Sjogerson, S. (2020). Greenhouse gas emissions resulting from conversion of peat swamp forest to oil palm plantation. Nature Communications, https://doi.org/10.1038/s41467-020-14298-w

Cossu, A., Stefania, D., Agnolucci, M., Cristani, C., Bedini, S., & Nuti, M. (2013). Assessment of the Life Cycle Environmental Impact of the Olive Oil Extraction Solid Wastes in the European Union. *The Open Waste Management Journal*. 12-20.

Cui, Z., Zhang, H., Chen, X., Zhang, C., Ma, W., Huang, C., … Dou, Z. (2018). Pursuing sustainable productivity with millions of smallholder farmers. Nature, 555(7696), 363–366. doi:10.1038/nature25785

Delabre, I., & Okereke, C. (2019). Palm oil, power, and participation: The political ecology of social impact assessment. *Environment and Planning – Nature and Space*. 1-21. DOI: 10.1177/2514848619882013

Department of State – United States of America. (2019). *Trafficking in Persons Report – June 2019*. https://www.state.gov/wp-content/uploads/2019/06/2019-Trafficking-in-Persons-Report.pdf

Dijkhorst, H. V., Kuepper, B., Piotrowski, M. (2018). Cerrado Deforestation Disrupts Water Systems and Poses Business Risks for Soy Producers. *Chain Reaction Research*. https://chainreactionresearch.com/wp-content/uploads/2018/10/Cerrado-Deforestation-Disrupts-Water-Systems-and-Poses-Business-Risks-for-Soy-Producers-3.pdf

Dreoni, I., Matthews, Z., & Schaafsma, M. (2022). The impacts of soy production on multi-dimensional well-being and ecosystem services: A systematic review. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2021.130182

Escobar, N., Tizado, E. J., Zu Ermgassen, E. K. H. J., Lofgren, P., Borner, J., & Godar, J. (2020). Spatially-explicit footprints of agricultural commodities: Mapping carbon emissions embodied in Brazil's soy exports. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2020.102067

Espadas-Aldana, G., Vialle, C., Belaud, J., Vaca-Garcia, C., & Sablayrolles, C. (2019). Analysis and trends for Life Cycle Assessment of olive oil production. *Sustainable Production and Consumption*. 216-230. https://doi.org/10.1016/j.spc.2019.04.003

European Commission. (2024, May). Corporate sustainability due diligence. europa.eu. https://commission.europa.eu/business-economy-euro/doing-business-eu/sustainability-due-diligence-responsible-business/corporate-sustainability-due-diligence_en

European Commission. (2023, July 31). Questions and Answers on the Adoption of European Sustainability Reporting Standards. europa.eu. https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4043

FAO. (2022). *Agricultural production statistics 2000–2022*. FAOSTAT Analytical Briefs, No. 79. https://doi.org/10.4060/cc9205en

Fleyfel, L. M., Leitner, N, K, V., Deborde, M., Matta, J., & Najjar, N, H, E. (2022). Olive oil liquid wastes– Characteristics and treatments: A literature review. *Process Safety and Environmental Protection*. 1031-1048. https://doi.org/10.1016/j.psep.2022.10.035

Florencia, F. M., Carolina,, T., Enzo, B., & Leonardo, G. (2017). Effects of the herbicide glyphosate on non-target plant native species from Chaco forest (Argentina). *Ecotoxicology and Environmental Safety*. 360-368. http://dx.doi.org/10.1016/j.ecoenv.2017.06.049

Gatti, R, C., & Velichevskaya, A. (2020). Certified "sustainable" palm oil took the place of endangered Bornean and Sumatran large mammals habitat and tropical forests in the last 30 years. *Science of the Total Environment.* 1-6. https://doi.org/10.1016/j.scitotenv.2020.140712

Gao, Y., & Serrenho, A. C. (2023). Greenhouse gas emissions from nitrogen fertilizers could be reduced by up to one-fifth of current levels by 2050 with combined interventions. *Nature Food*, 170–178. https://doi.org/10.1038/s43016-023-00698-w

Giorgio, O. D., Robinson, B. E., & Waroux, Y. L. P. D. (2022). Impacts of agricultural commodity frontier expansion on smallholder livelihoods: An assessment through the lens of access to land and resources in the Argentine Chaco. *Journal of Rural Studies.* 67-80. https://doi.org/10.1016/j.jrurstud.2022.05.014

Gomez, J. A., Infante-Amate, J., Gonzalez de Molina, M., Vanwalleghem, T., Taguas, E. V., & Lorite, I. (2014). Olive Cultivation, its Impact on Soil Erosion and its Progression into Yield Impacts in Southern Spain in the Past as a Key to a Future of Increasing Climate Uncertainty. *Agriculture.* 170-198. doi:10.3390/agriculture4020170

Gottald, E. (2018). Certifying Exploitation: Why "Sustainable" Palm Oil Production Is Failing Workers. *New Labor Forum.* 1-8. DOI: 10.1177/1095796018765767journals.sagepub.com/home/nlf

Government of Ontario. (2024, June 13). *Wetlands Conservation Partner Program.* Ontario.ca https://www.ontario.ca/page/wetlands-conservation-partner-program

GRI, United Nations Global Compact, WBCSD. (2015). SDG Compass – The guide for business action on the SDGs. https://sdgcompass.org/wp-content/uploads/2015/12/019104_SDG_Compass_Guide_2015.pdf

Guarino, F., Falcone, G., Stillitano, T., De Luca, A. I., Gulisano, G., Mistretta, M., & Strano, A. (2019). Life cycle assessment of olive oil: A case study in southern Italy. *Journal of Environmental Management.* 396-407. https://doi.org/10.1016/j.jenvman.2019.03.006

Guidi, C, F., & Berti, F. (2023). Labor exploitation in the Italian agricultural sector: the case of vulnerable migrants in Tuscany. *Frontiers in Sociology.* DOI 10.3389/fsoc.2023.1234873

Hong, O. W. (2023). Review on Carbon Footprint of the Palm Oil Industry: Insights into Recent Developments. *International Journal of Sustainable Development and Planning*, 18(2), 447-455. https://doi.org/10.18280/ijsdp.180213

Hosseini, S, E., & Wahid, M, A. (2015). Pollutant in palm oil production process. *Journal of the Air and Waste Management.* 773-781. DOI: 10.1080/10962247.2013.873092

Hunke, P., Mueller, E. N., Schroder, B., & Zeilhofer, P. (2014). The Brazilian Cerrado: assessment of water and soil degradation in catchments under intensive agricultural use. *Ecohydrology.* 1154-1180. DOI: 10.1002/eco.1573

International Olive Council. (2024). *OLIVE OIL PRICES - January 2024 update.* Internationaloliveoil.org. https://www.internationaloliveoil.org/wp-content/uploads/2024/01/IOC-prices-rev-0-1.html

Jamal, J. (2023). Illuminating Complex Governance in Palm Oil Sector and the Impacts on Child Labour: Towards A Case Study Among Independent Smallholders in East Malaysia (Sabah). *Social Science Review.* 8(1). 177-195. http://doi.org/10.29945/SEASSR.202305_8(1).0010

Ji, C., Zhai, Y., Zhang, T., Shen, X., Bai, Y., & Hong, J. (2021). Carbon, energy and water footprints analysis of rapeseed oil production: A case study in China. *Journal of Environmental Management.* https://doi.org/10.1016/j.jenvman.2021.112359

Jinkang, A. (2022). Vulnerability and exploitation of migrant workers in Italian Agriculture. *Perceptions*. https://www.perceptions.eu/wp-content/uploads/2022/04/PERCEPTIONS-Policy-Brief-Vulnerability-and-exploitation-of-migrant-workers-in-Italian-agriculture.pdf

Lahsen, M., Bustamante, M. M. C., & Dalla-Nora, E. L. (2016). Undervaluing and Overexploiting the Brazilian Cerrado at Our Peril. *Science and Policy for Sustainable Development.* 58:6. 4-15. https://doi.org/10.1080/00139157.2016.1229537

Lam, W, Y., Kulak, M., Sim, S., King, H., Hujibregts, M, A, J., & Chaplin-Kramer, R. (2019). Greenhouse gas footprints of palm oil production in Indonesia over space and time. *Science of the Total Environment.* 827-837. https://doi.org/10.1016/j.scitotenv.2019.06.377

Leguizamon, A. (2016). Environmental Injustice in Argentina: Struggles against Genetically Modified Soy. *Journal of Agrarian Change.* 16:4. 684-692. doi: 10.1111/joac.12163

Lende, G. S., & Velazquez, G. (2018). Soybean Agribusiness in Argentina (1990-2015): Socio-Economic, Territorial, Environmental, and Political Implications. *IntechOpen.* http://dx.doi.org/10.5772/intechopen.70463

MacWillian, S., Sanscartier, D., Lemke, R., Wismer, M., & Baron, V. (2016). Environmental benefits of canola production in 2010 compared to 1990: A life cycle perspective. *Agricultural Systems.* 106-115. http://dx.doi.org/10.1016/j.agsy.2016.03.006

Madaki, Y, S., & Seng, L. (2013). Pollution Control: How Feasible is Zero Discharge Concepts in Malaysia Palm Oil Mills. *American Journal of Engineering Research.* 239-252. https://www.ajer.org/papers/v2(10)/ZB210239252.pdf

Malaj, E., Liber, K., & Morrissey, C. A. (2020). Spatial distribution of agricultural pesticide use and predicted wetland exposure in the Canadian Prairie Pothole Region. *Science of the Total Environment.* https://doi.org/10.1016/j.scitotenv.2019.134765

Martínez-Dalmau, J., Berbel, J., & Ordóñez-Fernández., R. (2021). Nitrogen Fertilization. A Review of the Risks Associated with the Inefficiency of Its Use and Policy Responses. *Sustainability.* 13(10). https://doi.org/10.3390/su13105625

McMurry, S. T., Belden, J. B., Smith, L. M., Morrison, S. A., Daniel, D. W., Euliss, B. R., Euliss Jr. N. H., Kensinger, B. J., & Tangen, B. A. (2016). Land use effects on pesticides in sediments of prairie pothole wetlands in North and South Dakota. *Science of the Total Environment.* 682-689. http://dx.doi.org/10.1016/j.scitotenv.2016.04.209

Muhammad, A., Evenson, G. R., Stadnyk, T. A., Boluwade, A., Jha, S. K., & Coulibaly, P. (2018). Assessing the importance of potholes in the Canadian prairie region under future climate change scenarios. *MDPI.* 10(11). https://doi.org/10.3390/w10111657

Meijaard, E., Abrams, J. F., Slavin, J. L., & Sheil, D. (2022) Dietary Fats, Human Nutrition and the Environment: Balance and Sustainability. *Frontiers in Nutrition*. doi: 10.3389/fnut.2022.878644

Murphy, D. J., Goggin, K., & Paterson, R. R. M. (2021). Oil palm in the 2020s and beyond: challenges and solutions. *CABI Agriculture and Bioscience*, *2*(39). https://doi.org/10.1186/s43170-021-00058-3

Neves, B., & Pires, I. M. (2018). The Mediterranean Diet and the Increasing Demand of the Olive Oil Sector: Shifts and Environmental Consequences. *Region*. 5(1). 101-112. DOI: 10.18335/region.v5i1.219

Ogan, I. M., Dumont, M-J., & Ngadi, M. (2015). Palm oil: Processing, characterization and utilization in the food industry – A review. *Food Bioscience*, 26-41. https://doi.org/10.1016/j.fbio.2015.01.003

Omidvar, R., & Cordy, J. (2024). Act Now: Solutions for Temporary and Migrant Labour in Canada. *Standing Senate Committee on Social Affairs, Science and Technology.* https://sencanada.ca/en/committees/SOCI/Reports/44-1#?filterSession=44-1

Pfarrer, M. D. (2010). What is the Purpose of the Firm?: Shareholder and Stakeholder Theories. In *Good Business* (1st ed., pp. 86–93). Routledge. https://doi.org/10.4324/9780203850626-9

Qaim, M., Sibhatu, K, T., Siregar, H., & Grass, I. (2020). Environmental, Economic, and Social Consequences of the Oil Palm Boom. *Annual Review of Resource Economics.* 321-344. https://doi.org/10.1146/annurev-resource-110119024922

Rapa, M., & Ciano, S. (2022). A Review on Life Cycle Assessment of the Olive Oil Production. *Sustainability.* doi.org/10.3390/su14020654

Restuccia, D.; Prencipe, S.A., Ruggeri, M., Spizzirri, U.G. (2022). Sustainability Assessment of Different Extra Virgin Olive Oil Extraction Methods through a Life Cycle Thinking Approach: Challenges and Opportunities in the Elaio-Technical Sector. *Sustainability.* https://doi.org/10.3390/su142315674

RSPO (2011, November 11). *Fact Sheet.* RSPO.org. https://rspo.org/wp-content/uploads/RSPOFACTSHEETFINALRT91.pdf

Schulte, L. A., Niemi, J., Helmers, M. J., Liebman, M., Arbuckle, J. G., James, D. E., Kolka, R. K., O'Neal, M. E., Tomer, M. D., Tyndall, J. C., Asbjornsen, H., Drobney, P., Neal, J., Ryswyk, G. V., & Witte, C. (2017). Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn–soybean croplands. *PNAS.* 114(42). 11247-11252. https://doi.org/10.1073/pnas.1620229114

Sedibe M. M., Mofokeng, A. M., & Masvodza, D. R. (2023). Soybean Production, Constraints, and Future Prospects in Poorer Countries: A Review. In Hasanuzzaman, M. (Eds.), *Production and Utilization of Legumes - Progress and Prospects.* http://dx.doi.org/10.5772/intechopen.109516

Sevenster M. (2023) Greenhouse gas emissions from the cultivation of canola oilseed in Australia. *CSIRO*, https://energy.ec.europa.eu/document/download/5a0d05d8-aea8-45f0-bdf8-46c27ac77900_en?filename=2022_NUTS2_report_Australia.pdf&prefLang=pt

Sohn, S., Pandian, S. Oh, Y., Kang, H., Ryu, T., Cho, W., Shin, E., & Shin, K. (2021). A Review of the Unintentional Release of Feral Genetically Modified Rapeseed into the Environment. *Biology.* https://doi.org/10.3390/biology10121264

Statistics Canada. (2024). Temporary foreign workers in the agriculture and agri-food sectors, by industry. *Statcan.gc.ca* https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210021801

Sustainable Solutions. (2024). *Life Cycle Assessment of U.S Soybeans, Soybean Meal, and Soy Oil.* https://www.nopa.org/wp-content/uploads/2024/02/2024-US-Soy-LCA-Study_PEER-REVIEW-FINAL.pdf

Tobiasz-Salach, R. (2021). Rapeseed, Its Modifications and Danger of Dissemination in the Natural Environment. *Acta Sci. Pol. Agricultura*, 20(2), 71–80. DOI: 10.37660/aspagr.2021.20.2.3

Tsarouhas, P., Anchillas, Ch., Aidonis, D., Folinas, D., & Maslis, V. (2015). Life Cycle Assessment of olive oil production in Greece. *Journal of Cleaner Production.* 75-83. http://dx.doi.org/10.1016/j.jclepro.2015.01.042

United Nations – Summit of the Future. (2024). Zero Draft of the Declaration on Future Generations. https://www.un.org/sites/un2.un.org/files/co-facilitators_zero_draft_of_the_declaration_on_future_generations_26_march_2024_final_.pdf

Uylaser, V., & Yildiz, G. (2014). The Historical Development and Nutritional Importance of Olive and Olive Oil Constituted an Important Part of the Mediterranean Diet. *Critical Reviews in Food Science and Nutrition.* 54:8. 1092-1101. DOI:10.1080/10408398.2011.626874

Vallejos, M., Faingerch, M., Blum, D., & Mastrangelo, M. (2020). 'Winners' and 'losers' of the agricultural expansion in the Argentine Dry Chaco. *Landscape Research.* https://doi.org/10.1080/01426397.2020.1808965

Warren, M., Frolking, S., Dai, Z., & Kurnianto, S. (2017). Impacts of land use, restoration, and climate change on tropical peat carbon stocks in the twenty-first century: implications for climate mitigation. *Mitig Adapt Strateg Glob Chang.*22(7) 1041-1061. doi: 10.1007/s11027-016-9712-1.

Whitfield, C. J., Cavaliere, E., Baulch, H. M., Clark, R. G., Spence, C., Shook, K. R., He, Z., Pomeroy, J. W., & Wolfe, J. D. (2024). An integrated assessment of impacts to ecosystem services associated with prairie pothole wetland drainage quantifying wide-ranging losses. *Facets.* 1-15. dx.doi.org/10.1139/facets-2023-0207

Wright, C. K., & Wimberly, M. C. (2013). Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *PNAS.* 110(10). 4134-4139. https://doi.org/10.1073/pnas.1215404110

Zheng, Q., & Liu, K. (2022). Worldwide rapeseed (Brassica napus L.) research: A bibliometric analysis during 2011–2021. *Oil Crop Science.* 157-165. https://doi.org/10.1016/j.ocsci.2022.11.004

Zhunusova, E., Ahimbisibwe, V., Sen, L. T. H., Sadeghi, A., Toledo-Aceves, T., Kabwe, G., & Günter, S. (2022). Potential impacts of the proposed EU regulation on deforestation-free supply chains on smallholders, indigenous peoples, and local communities in producer countries outside the EU. *Forest Policy and Economics.* https://doi.org/10.1016/j.forpol.2022.102817

Zumente, I., & Bistrova, J. (2021). ESG Importance for Long-Term Shareholder Value Creation: Literature vs. Practice. *Journal of Open Innovation: Technology, Market, and Complexity.* 7(*127*). https://doi.org/10.3390/joitmc7020127