Vaasan yliopisto
UNIVERSITY OF VAASA

Md Mehedi Hasan (2400097) and Roji Karki (2400299)

Public Acceptance of a Controversial Technology: Stakeholder Perspectives on GM biofuel in News Media

Master Thesis

School of Technology and Innovation
Industrial Management
Master’s Program in industrial Engineering and Management

Vaasa 2025

UNIVERSITY OF VAASA
School of Technology and Innovation

Author:	Md Mehedi Hasan (2400097) and Roji Karki (2400299)
Title of the thesis:	Public Acceptance of a Controversial Technology: Stakeholder Perspectives on GM biofuel in News Media: Master Thesis
Degree:	Master’s Programme in Industrial Engineering and Management
Discipline:	Master’s in Industrial Management
Supervisor:	Jouni Juntunen
Year:	2025 **Pages:** 91

ABSTRACT:

Public acceptance of genetically modified (GM) crops has some complexity due to the technological controversy and different opinions of different stakeholders. This study has examined the public acceptance of GM biofuel by analyzing the stakeholder’s roles in gm biofuel ecosystem, stakeholder’s sentiment over the time, finding out the supportive and critical aspect of GM biofuel that may impact the public acceptance. Furthermore, this study also analyzed tensions developed between stakeholders due to the conflict of interest and stakeholder’s positions on policy aspects. To do this study empirically, it has followed the qualitative review of an extensive media corpus as the foundation of the analysis. Besides, the data is collected from news publications from various international sources released between 2005 and 2025, to analyze them. The data has been sourced from LexisNexis, a global database that compiles newspaper, magazine, and online articles. Microsoft Excel has been used for data management, manual coding, thematic analysis, and visual presentation. Also, NVivo 15 software has been used to analyze the word frequency and word cloud. Moreover, there are ten different types of stakeholders that have been discussed. Moreover, supportive discourses are characterized by frames of innovation, sustainability, and energy security, whereas critical discourses highlight concerns about contamination and ethical uncertainty, food security, and corporate control. The study has also discussed the frequently mentioned tensions around GM biofuel such as food versus fuel along with other identified tensions, for example, innovation versus precaution, and trade competitiveness versus regulatory sovereignty have influenced the way people think about GM biofuel. In stakeholder’s sentiment it is found that negative sentiment is higher than positive sentiment due to the unknown risks associated with GM crops, but the difference remains relatively minimal. Conclusively, the public acceptance of GM biofuel technology cannot just be taken as a case of technological innovation but as a matter of gaining trust through integrity, policy, and communication.

KEYWORDS: GM crops, GM biofuel, Controversial Technology, Public Acceptance, Stakeholder’s Perspective, Media Framing, Tensions, Policy

Table of Contents

List of Table

List of Figures

Abbreviation:

ANAPO	Association of Oilseed and Wheat Producers
CEPB	Confederation of Private Businessmen of Bolivia
CONABIA	Comisión Nacional Asesora de Biotecnología Agropecuaria
COP	Conference of the Parties
E10/E15	(Ethanol-gasoline blend) • **E10** = 10% ethanol, 90% gasoline • **E15** = 15% ethanol, 85% gasoline
EFSA	European Food Safety Authority
ETC	Action Group on Erosion, Technology and Concentration
EV	Electric Vehicle
HB4	A specific genetically modified wheat variety developed by Bioceres Crop Solutions Corp
HFCS	High-Fructose Corn Syrup
ILUC	Indirect-land-use change
IP	Intellectual Property
ISCC	International Sustainability and Carbon Certification
OECD	Organization for Economic Cooperation and Development
PBFCC	Peasant and Indigenous Biofuels and Climate Change Campaign
RSB	Roundtable on Sustainable Biomaterials
SAF	Sustainable Aviation fuel
SENASA	Servicio Nacional de Sanidad y Calidad Agroalimentaria
USMCA	United States–Mexico–Canada Agreement

1 Introduction

This section is going to describe the background of the study where the history of GM biofuel and its future prospect has been discussed. Also, the research questions, research objectives, research gaps and the structure of the study have been discussed in this section.

1.1 Background of the Study

Due to the increasing demand for fossil fuels and their environmental impact, the necessity of finding a sustainable alternative has been anticipated. It has attracted scientists and experts to explore renewable energy. With considerable achievements in solar and wind power, researchers are now focusing on bio-based energy technology. By 2050, approximately 7.5 to 37% of the world's energy consumption will be produced by bioenergy (Errera et al., 2023).

According to Zhi et al. (2023), bioenergy has a thousand-year history. In ancient times, people used to burn wood to keep themselves warm and for cooking. From there, progress started, and the revolution of bioenergy was initiated. Afterwards, during the Industrial Revolution, the use of coal and other fossil fuels gained traction, but because of their drastic impact on the environment, a substitute was necessary. In the late 20th century, the establishment of the very first biodiesel was a new technological breakthrough in producing bioenergy.

Although bio-based energy such as biodiesel has low carbon intensity, using traditional crops for biodiesel is under critical examination (Wan et al., 2017). It is expensive and faces controversies such as food versus fuel. This is a limitation of bioenergy technology being scaled up commercially. However, genetic engineering and new breeding technology can produce essential biomass for profitable biofuels, as GM crops have higher feedstock yields and higher energy gains.

According to Ambaye et al. (2021), recent progress in bioenergy technology is the use of GM crops in the large-scale production of biofuels. Manetti (2022) defined GM crops as plants whose DNA may be changed through genetic engineering methods, where scientists can select desirable genes to insert into the DNA of the plant to modify it. The possible benefits of GM crops include being more nutritious, disease- and drought-resistant, insect-resistant, and having faster growth. However, the use of GM crops in biofuel is also debatable due to unintended ecological consequences, social and economic impacts, and issues of public acceptance.

1.2 Research Question

The aim of this research is to analyze media materials and identify the key factors influencing public acceptance of GM biofuel. To achieve this, the research mainly focuses on the following research questions:

1. Who are the key stakeholders in the GM biofuel ecosystem, and what roles are they playing in influencing public acceptance?

2. What narratives, frames, and discourses are constructed by different groups of stakeholders with both supportive and critical concerns, and how are tensions developed between stakeholders for instance, the Food vs. Fuel argument?

3. How does the media cover stakeholder positions on existing standards, regulations, and policies?

1.3 Research Objective

The objective of the study is to identify the stakeholders, define their roles, and determine their representation in the news publications. The purpose of the stakeholder analysis is to find out their influence in public acceptance of GM biofuel technology. Also, this study aims to analyze the frequency of stake in the news corpus, their sentiment regarding GM biofuel and an overall understanding of their opinion which has influence in public acceptance.

Besides, this study also aims to analyze discourse, narratives, and content to find out how GM biofuel has been framed in news publications, for instance, some stakeholders may frame GM biofuel as a technological innovation, whereas others may oppose this and argue about biosafety. Also, the tensions formed around GM biofuel due to conflicting interests, for example, the food vs. fuel argument and other tensions that have grown over time will be studied.

Furthermore, this research intends to investigate stakeholder's positions towards GM biofuels policy and standards. In conclusion, the goal of the study is to identify the stakeholders and their role in the GM biofuel ecosystem, investigate their representation in media publications, their influence on public acceptance of this Gm biofuel technology, their sentiment and positions towards policy.

1.4 Research Gaps

Despite growing research on renewable energy technologies and biofuels, there are still very few focused research papers on public acceptance of GM biofuels. "Only a few studies have tried to establish what arguments or frames shape public attitudes toward biofuels, and the results are inconsistent" (Delshad and Raymond, 2013). In the context of GM biofuels, the number of studies is even more limited, although GM crops and biofuels have been widely explored as separate areas of research.

In earlier studies, stakeholders are discussed in terms of who they are and their roles in the biofuel ecosystem rather than evaluating their opinions to understand how they communicate, frame, and influence public perception in the GM biofuel context. Also, different studies have emphasized different stakeholder groups; therefore, comprehensiveness is still lacking. For instance, Schillo et al. (2017) mentioned that although it is important to capture all stakeholders, two influential stakeholder groups, researchers and investors are missing in their analysis of biofuels.

Furthermore, tensions developed around GM biofuel over time were presented in some studies; however, they have discussed only specific topics like food vs. fuel or specific issues such as local wastewater treatment (Leibensperger et al., 2021). Other conflicts and arguments that have developed tensions over GM biofuel have not been articulated. Also, the issue of stakeholders' involvement in policymaking is understudied. Moreover, sentiment analysis, word frequency analysis, and supportive and critical framing have not been explicitly examined in the context of GM biofuels.

Therefore, this study aims to take a more integrated approach to capture the public acceptance of GM biofuel by analyzing the stakeholders comprehensively, identifying the supportive and critical frames from discourse and content analysis, examining the tensions that have grown over time, and exploring stakeholders' opinions on policies introduced by the authorities.

1.5 Structure of the Study

The thesis consists of five main sections:

Section One is the introductory chapter that discusses the background of the study, research questions, objectives, research gaps, and structure of the study.

Section Two is literature review, discusses the existing knowledge on advancement of GM biofuel technology, stakeholder dynamics, media influence, controversies, conflicts, debates, and regulations.

Section Three is the methodology section. Research methods, data sources, and theoretical frameworks (framing theory, discourse analysis, and content analysis) have been explained in this section.

Section Four presents the research findings. It explains the overview of the data analyzed in the corpus, followed by an analysis of stakeholders, framing, tensions, and policies on GM biofuel that influence public acceptance.

Section Five contains discussion and conclusion, where the findings are discussed in relation to existing literature and the research gap, along with the study's limitations, recommendations for future research, and the conclusion.

2 Literature Review

This section reviews existing studies on GM biofuel technology, stakeholders involved in the GM biofuel ecosystem and their roles, media influence on public acceptance, tensions formed over time around GM biofuel, and policy matters. The aim of this chapter is to establish the theoretical and conceptual foundation of the study by analyzing previous research.

2.1 Biotechnological Advances in GM Biofuel Technologies

Recent progress of biofuel has been focused on genome to improve the efficiency of feedstock. CRISPR/Cas is currently used to accurately adjust the genes that regulate the lignin and cellulose in corn, wheat, and sugarcane to increase the fermentable sugar output which can be converted into ethanol (Chen, Zhao, and Guo, 2024). Miscanthus has transformation pipelines that facilitate steady, high-biomass lines that can be converted into industrial products (He, Xu, Zhang, & Jiang, 2022). Oil seed crops like canola develop paralleled with the awakening of base editing to increase oil composition in order to make biodiesel (Yuan, Zhang, and Liu, 2024). These technological progresses might help GM biofuel production in a large scale.

Furthermore, multi-gene stacking enhances accessibility and stress resistance, improving consistency in large-scale cultivation (Dida, Nyoni, & Chidamba, 2024). Gene editing is performed by deleting, correcting, or replacing DNA, which allows controlled modification within an endogenous gene without necessarily inserting any exogenous material (Auer & Dene, 2014). The authors also observed that when it comes to the introduction of defective genes or inserting a new functionality, new DNA is introduced into the genome. Besides, technologies like CRISPR/Cas systems have been termed ground-breaking instruments of genetic modification in crops. They can help accelerate the development of high-yielding and climate-resilient crop varieties (Chen et al., 2024). Moreover, GM crops for both food and biofuel have been seen as a promising solution due to their high yield (Xie & Peng, 2011). However, the technology remains controversial because of the associated environmental risks to natural ecosystems (Leibensperger et al., 2020).

Moreover, Biofuel can be classified based on generational shifts. First-generation biofuel is produced from food crops; therefore, it has faced negative consequences as food and feed prices are involved (Sorda et al., 2010). The second-generation biofuel is produced from non-food crops, where jatropha is used as a key feedstock (Kant et al., 2025). The authors also mentioned that third-generation biofuel is not involved in food competition but is not economically competitive. Later on, the concept of producing fourth-generation biofuels through genetically modified algae aims to overcome the limitations of previous generations of biofuel (Shokravi et al., 2021).

Finally, according to Lee et al. (2013), it is highly attractive to use biotechnology for producing biofuels. Biodiesel and bioethanol are the two main types of liquid biofuels used for transportation. Biodiesel can be produced from any fat or oil, and the process is relatively simple. The yield is almost double the amount of energy used to produce the biodiesel. However, the main challenge is that the resources are limited to seed crops such as soybean and palm oil for biofuel production. Bioethanol is also a food-based fuel produced from edible crops such as sugarcane, potato, oilseed, corn, wheat, sunflower, and soybean (Nikolić et al., 2016). However, the yield is only about 25% of the energy used to produce bioethanol (Hill et al., 2006).

2.2 Key Stakeholders in the GM Biofuel Ecosystem

According to Freeman and Reed (1983), stakeholders can be defined in two ways: the narrow view and the wide view. In the narrow view, a stakeholder is defined as a group or individual on whom the organization depends for its survival, whereas in the wide view, a stakeholder is any group or individual who can affect or be affected by the achievement of the organization’s objectives. Stakeholders can also be classified based on power, legitimacy, and urgency (Mitchell et al., 1997). Based on these fundamental definitions, the stakeholders in the GM bioenergy ecosystem are categorized into members of the supply chain and external stakeholders (Gold, 2011).

In the GM bioenergy ecosystem, forest and landowners (Mayfield et al., 2007), plant operators (Belle et al., 2003), and farmers (Ellegaard, 2003) are considered as supply chain actors, whereas the government, non-governmental organizations (NGOs), associations, residents, consumers, and citizens are considered as external stakeholders (Gold, 2011). In addition to that, the media is categorized as a critical stakeholder, as they can play an essential role in the success of biofuel commercialization (Schillo et al., 2017). Mayfield et al., (2007) believe that collaboration among stakeholders is required for the development of GM bioenergy.

According to Leibensperger et al. (2021), producers are mainly farmers. Producers considered as initial actors in the GM biofuel ecosystem, and their acceptance mainly determined by economic factors, local availability, risk-taking attitude, and environmental factors. Rural communities, consisting of farmer's families and local leaders, have the chance of deeply affected by the development of biofuels in their areas. Moreover, perceived environmental threats and the loss of local empowerment can lead to the protest from local community, even though it may have positive results such as generating employment and developing local regions (Rossi & Hindrichs, 2011).

Moreover, as a market acceptor consumers preference, risk sensibility, and environmental doubts play a crucial role in the production and trade of biofuel. Meanwhile, by investing and policymaking the government plays a double role in this ecosystem. Government either support or hamper the establishment of such ecosystem by their act such as Regulations, subsidies, and development programs (Leibensperger et al., 2021).

According to Mai-Moulin et al. (2019), as a crucial stakeholder non-governmental organization (NGOs) influence public discourse and policy through advocacy and their engagement with media. They have different views where favorable, subject to strict sustainability conditions and critical views from the risks to ecosystems and land rights. Borges et al. (2020) identified that in Brazil, NGOs have low confidence in GMOs and they require independent research, social engagement, and ethical supervision in terms of GM biofuel development. Other than that, they are questioning the risk related matters, corporate control and social justice in further development of GM biofuels operations.

Furthermore, Academia and consulting organizations as stakeholders offering scientific knowledge, sustainability assessments, and policy advice. Mai-Moulin et al. (2019) noted that, academic and consulting scientists are usually considered as the most credible sources of information, although they are often not taken into consideration within the framework of public and policy discourse. They are pushing evidence-based decision making but evidence is rarely affecting the policy as theirs no effective communication channel. Borges et al. (2020) observed that, in the Brazilian context stakeholders from academia tend to be pro-GMO meaning demanding clear advantages, also they noted several challenges in communicating the significance of scientific information to the public.

2.3 Media Influence on Public Acceptance

The media is affecting the public acceptance of GM biofuel by representing the customers behavior and challenging new technology such as GM biofuel from different angle. Mohr and Höhler (2023) criticize mainstream mass media for failing to provide an overall societal view of digital agriculture. Their analysis reveals that the media tend to focus on negativity, which consequently influences people and their judgment on policy decisions.

Media framing and the presentation of an issue play a role in shaping societal perception and personal integration of technological advancements. Chong and Druckman (2007) argue that public acceptability of certain actions is highly dependent on the frames that dominate the discourse, especially in situations where there is a contest between conflicting and opposing stories placed at the center of publicity. Concerns raised by the media on issues such as safety, ethical implications, or environmental impact dominate public attention and thus steer public opinion, if not the decisions of top policymakers themselves (Nelson, Clawson, & Oxley, 1997; Scheufele, 1999).

Gakpo and Baffour-Awuah (2024) emphasize that the media in Ghana have been the most important factor in forming public opinion about GMOs, particularly when Bt cowpea, the very first genetically modified crop in Ghana, received its approval. Conducting a study of three leading Ghanaian digital news outlets, they found that media framing changed remarkably from highlighting health and environmental risks before the approval to mainly discussing potential food security benefits afterward. According to Du and Rachul (2012), the Chinese media's tone and content regarding the issue of genetically modified organisms were heavily influenced by the government policy and the official communication, with the majority of the reports showing either a supportive or neutral attitude that was consistent with the state’s viewpoint on biotechnology. This indeed shows how institutional communication, for instance from bodies assuring safety, guides media narratives and public perception in favor of whatever has been assured.

Moreover, media can influence the public by representing the risk of GMO OR GM biofuel from critical perspective. For instance, due to medias negative portrayal Russia’s government’s ban on GMOs, leading to widespread public debate (Bickell, 2019). In the same way, in Europe media highlighted the dangerous impact of biotechnology without mentioning its advantages lead the public distrust (Vilella-Vila & Costa-Font, 2008; Lynas et al., 2022). Therefore, it is important to have accurate and unbiased communication through the media to reduce misinformation and develop public confidence in GMO-based biofuels.

2.4 Tensions Among Stakeholders in GM Biofuel Debates

According to Freeman et al. (2020), stakeholder theory addresses the challenge of balancing the interests of different stakeholders in a broader context, such as value creation and business ethics. They point out that conflicting narratives among stakeholders are often the result of underlying tensions. In the case of GM biofuels, different stakeholders have varying and often conflicting interests (Ruan et al., 2019). These conflicting interests give rise to tensions within the GM biofuel discourse.

The most discussed topic in public tension around GM biofuel is food vs. fuel. According to Lane (2015), “Issues such as change of land use and food versus fuel have emerged as a strong barrier for biofuel development.” Pimental et al., (2009) added, consumers and non-governmental organizations (NGOs) believe that changing the use of fertile land and resources intended for agriculture into one for fuel production would result in a shortage of food, an increase in global food prices, and a danger to the lives of people living in rural areas—and such issues have been ignored by some scientists and policymakers . Research indicates that the use of food crops for bioenergy feedstocks particularly leads to overlapping social and economic impacts, which result in this divide becoming larger and more pronounced between industrial and societal interests (Ahmed et al., 2021; Tomei & Helliwell, 2016; Filip, 2019).

According to Bauer (2002), one of the reasons behind the conflict between the public and biotechnology scientists and investors is the production of GM crops for biofuel. The author mentioned that the public usually sees genetic modification as unreal, unnatural, and risky, while biotechnology companies, scientists, and investors consider it a new way to achieve sustainable energy and climate solutions. Industrial stakeholders are focusing on the benefits of yield efficiency and technological advancement despite of the GM biofuel’s ethical, ecological, and safety issues (Frewer et al., 2013; Marris, 2015). This inconsistency proves the contradiction between innovation and safety, where the perception of ethical and moral responsibilities conflict with technological advancement (Bauer, 2002; Frewer et al., 2013; Marris, 2015), causes distrust and raise questions on the stakeholder’s self-interest.

According to Ponte (2014), the issue of fare trade has articulated now due to the expansion of GM biofuel over the world. On the one hand global organizations such as WTO is pushing to in favor of adopting a common regulatory framework for gaining the patent and accessing the global market (Clapp, 2018). On the other hand, civil society argues to keep the policy free from foreign influence to protect the environment and serve the common interest of society (Daugbjerg & Feindt, 2017). This dispute represents the broader confrontation between the globalization process and local control in the spheres of sustainability governance.

2.5 Stakeholder Positions on Policies

The policy of biofuel is designed by focusing the market expansion and independence of national energy, however these intentions are not always serving the sustainability agenda. On the one hand governments are concentrating on market expansion and energy security by implementing the policy (Sparks & Ortmann, 2011). In contrast, non-governmental stakeholders are often opposing the GM biofuel due to environmental and ethical reasons (Turcksin et al., 2011). This contradiction causes disagreement in policy governance issues and this conflict of interest later inhibit the unity in policy formulation (Schillo et al., 2017).

Moreover, rural and local communities support policy if it serves the local interest, however, these stakeholders also oppose the policy when it is in favor of large-scale corporate control (Rossi & Hindrichs, 2011). Similarly, farmers prefer long-term economic stability to short-term gains in large plantation-scale systems (Chin et al., 2014). Local communities are concerned about agribusiness dominance, uncertain economic returns, and environmental degradation; therefore, they want more involvement in decision-making (Atwell et al., 2009).

Augustenborg et al. (2012) also add that the trust and cooperation of stakeholders can be improved through government policies addressing climate change and sustainable land management.

The success of policies relating to biofuels and GMOs heavily depends on public opinion and consumer behavior as well. Biofuels are directly related to the fuel market and directly influence the prices of transportation and consumer goods (Youngs et al., 2012). Consumer acceptance can be divided into community and market dimensions, which manifest social and economic motivations (Chin et al., 2014). To address public demand, the UK implemented mandatory labeling in 2013, which is the opposite approach to that followed by the U.S. (Ruan et al., 2019). Moreover, to implement policy effectively, stakeholders' trust, transparency, and awareness are required.

Furthermore, policy analysis reveals a clear contrast between the U.S. and European approaches to GMO regulation. The United States prefers a risk-based and innovation-oriented policy to promote biotechnology development (Parrott et al., 2020), whereas the European Union prefers environmental ethics, biodiversity protection, and public participation (Wickson, 2014). This contrast was further highlighted by the 2004 disagreement between the U.S. and the EU, which was a dispute over the five-year ban on GM crops by the EU against the U.S. The case was challenged by the World Trade Organization because the European policy was seen as a response to pressure exerted by the U.S. to soften its strict GMO policy (Farmers Guardian, 2004). Ultimately, these contrasting philosophies highlight differences between economic growth and ecological integrity.

2.6 Summary of literature review

In summary, it consistently points out that the coexistence of technological innovations, engagement with different stakeholders, media coverage, and government regulations are the main determinants of the success of GM biofuel adoption. In spite of the fact that GM biofuels have the potential to be part of the sustainable energy solution, their use is mainly determined by stakeholders' communication and the way they handle ethical and environmental issues. The media's role in the matter is largely to influence public perception—either by developing trust through accurate reporting or creating resistance by spreading fabricated information. Stakeholder tensions are sometimes caused by conflicts of interest and varying degrees of understanding. Hence, the use of clear communication, strong regulatory systems, and collaborative methods will not only be needed but will also be a prerequisite for the responsible and socially accepted development of GM biofuels.

3.Methodology

This chapter explains the methods followed in this study, the data sources, and how the data were analyzed. The theoretical framework is also presented in this chapter, where framing theory, discourse analysis, and content analysis are described and explained to show how they have helped examine the discourse and narratives in this study.

3.1 Research Method

To analyze the public acceptance of GM biofuel, this study followed a qualitative approach with an abductive logical inquiry from news discourse. The abductive coding approach fits the analysis, as prior research proposed well-known categories of subject matter, for instance, types of stakeholders, narratives on public tensions, and arguments on policies. However, rather than directly confirming them, this study further explores the narratives and discourse to modify existing theories. Consequently, the analysis develops codes from earlier theories and empirical data to produce both expected and unforeseen explanations.

Media framing theory, supported by discourse and content analysis, guides the methodological approach, enabling a detailed exploration of recurring themes, stakeholder roles, tensions and stress arising from the use of GM biofuel, an overview of policy and standards, and how these all influence the public acceptance of GM biofuel. A wide range of literature reviews is performed from different backgrounds, such as science, technology, business, and timeline. This helped to understand and identify the issues related to GM biofuel, key stakeholders, recent changes in media narratives about GM biofuel, and their possible effects on public acceptance.

The analysis combined content analysis and manual coding. Relevant contexts were first identified and marked in the PDF corpus. After that the context transferred into a Microsoft Excel database for analysis. In the Excel database, thematic analysis is performed from the coded context. Based on the content of the news, stakeholders were categorized using an approach that combined insights from existing literature and abductive analysis from the dataset itself. Furthermore, the contexts were categorized as positive, negative, or neutral for sentiment analysis. The dataset was organized and refined using Microsoft Excel's data management tools, which facilitated the categorization, cleaning, and segmentation of coded material for further analysis. Similar data has been inserted in NVivo 15 tools to obtain word frequency and analyze the frequency of GM crops, stakeholder's frequency and frequency of countries in the news corpus. This provided an initial sense of the most recurrent shareholders, concepts, and themes appearing in the dataset. It also helped with manual coding in Microsoft Excel to understand the themes, patterns, and overall scenario.

3.2 Data Sources

LexisNexis, a comprehensive database for academic research, was used for collecting news publications. It allowed access to a vast number of news articles related to bioenergy technology. A broad corpus of media texts (newspapers, magazines, corporate newsletters, TBD) was obtained from the years 2005 to 2025. The keywords included (GMO OR genetically) AND (bioenergy OR biofuel OR GMO crops OR biomass OR renewable energy) to find the news articles from LexisNexis. The search was limited to news published in the English language.

Initially, 838 news publications were downloaded from LexisNexis. The preliminary database was first sorted by the headlines of the news, and duplicate items were marked. Later, duplicate news was identified from the news headline and removed from the database. Further, to access the relevancy the news was screened and identified news that is not relevant to this study and removed them. After removing duplicate and irrelevant files the dataset has been fixed to 416 news from different part of the world. From the selected database context were coded based on recurring themes, key arguments, and stakeholder perspectives.

3.3 Data Analysis Framework

The three relevant frameworks named Framing Theory, Discourse Analysis, and Content Analysis are defined in this section to establish the analytical basis for this study. These analytical tools indicate their importance in the analysis of how media and information are constructed, communicated, and interpreted.

3.3.1 Media Framing

According to Chong and Druckman (2007), a few selected individuals mostly influence the public opinion. In framing, to influence the audience's perspective certain aspect of the issues are highlighted. Media driven framing has a strong influence in shaping public opinion (Delshad & Raymond, 2013).

This study used framing theory as an analytical lens to understand stakeholder's standpoints represented in the media regarding the public acceptance of GM biofuels. The analysis also helps to identify the specific aspects of GM biofuels in news media that has influence to shape public acceptance. This paper discusses the position of stakeholders along with the roles in the GM biofuel ecosystem by examining recurring frames. The theory of framing, therefore, guides the interpretation of media coverage and contribution to public acceptance.

3.3.2 Discourse Analysis

Discourse analysis is a powerful tool to examine the meaning of different communication practices, define social realities, construct ideology, and build public opinion. Gamson (1989) thinks that media discourse is not only reporting the facts but it works as an active force that constructs meaning by selecting the narratives, framing the events, and emphasizing a set of ideals. It defines how people interpret and engage with complex issues.

In this study, discourse analysis is used to find out the underlying senses of narratives that is used in news publications on GM biofuel. It also helps to identify the conflicting narratives and explore tensions between different stakeholders. It also helped to reveal supportive and critical discourses which have influenced the public acceptance of GM biofuel. Rather than focusing on linguistic form, the analysis examines how narratives in the news presented stakeholder statements in news publications. Moreover, discourse analysis is used as a tool to identify the narratives used to normalize, question, or resist GM biofuel technology.

3.3.3 Content Analysis

Content analysis is a systematic and objective oriented method which is used to describe and measure qualitative data to understand meaning of the context (Elo et al., 2014). It includes data classifying into different groups and discovering the patterns or themes which can represent the research phenomenon. The process can be performed inductively, where the categories develop from the data. Elo et al. (2014) states that the process of analysis usually has three phases which are preparation, organization, and reporting, each of this ensures the trustworthiness and validity of the results.

In this study as a part of the content analysis, a sentiment analysis has been performed where the contexts were categories in three different categories, which are positive, negative, and neutral, based on expressed meaning. This analysis provides an in depth understanding of stakeholder’s opinion on GM biofuel and makes it possible to capture emotional tones along with the theme. Therefore, by using content analysis, it is possible to extract significant insights and gain a comprehensive perception of stakeholders’ discussions on GMO-based bioenergy.

4. Findings

This chapter presents the results of this study. It contains five parts. The overview of the news corpus represents the results of data analysis, particularly diversified the data is, the most frequently mentioned GM crops in the corpus, and stakeholder's sentiment analyses. The next part is on key stakeholders which explains the frequency of stakeholders in the corpus, stakeholder's voices toward GM biofuel, and their influence in public acceptance. In the third part, supportive and critical frames are represented. After that, the tensions formed between stakeholder groups on different issues are presented. In the final section, stakeholder's position on policies is discussed, including existing policies and standards, along with stakeholder's involvement and perceptions.

4.1 Descriptive Analysis of Media Coverage on GM Biofuel

This section provides an overview of the empirical corpus examined in this study, offering descriptive insights into the media representations of genetically modified biofuels. It describes the geographic coverage of the corpus across different countries and regions, the number and distribution of stakeholder mention, and the GM crops that were most frequently cited. Additionally, the section presents a year-by-year sentiment analysis, which interprets the temporal aspect of media coverage. Together, these analyses demonstrate the extent, variety, and evolution of the discourse about GM biofuel in the news, thus providing the empirical basis for the following thematic and stakeholder-centered analyses.

4.1.1 Geographic coverage of GM biofuel by countries

The news corpus covered a wide range of geographic locations to address the research questions of this study. Figure 1 portrays the geographical distribution of GM biofuel coverage by count of the countries in the news publications considered for this study. As presented in the map, Asia represents the highest percentage at 26.8%, followed by Europe (25.1%) and Africa (22.0%). The proportion of North America is 17.7%, followed by South America and Oceania/Australia account for 7.0% and 3.1%, respectively.

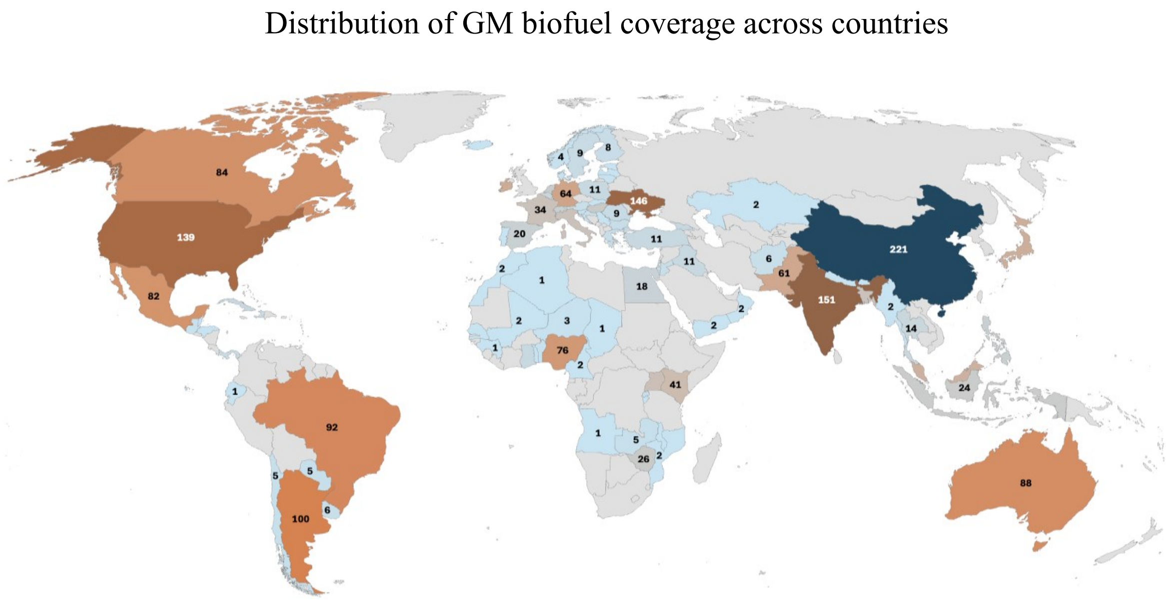

Figure 1: Distribution of GM biofuel coverage across countries

The distribution is indicating that the various areas are considered in this study which has given a comprehensive understanding of stakeholder's opinion and the understanding of public acceptance along with the understanding the tension, sentiment and policy from a global point of view. Furthermore, it should be noted that along with these countries appeared in the news corpus in Figer 1, the corpus also contains regional references such as Africa (408 times), followed by Europe (203), America (193), and Asia (110) times. However, this regional count is not shown on the map, as the map only represents the country-level data.

4.1.2 Frequency of GM Crop Mentions in the GM Biofuel Corpus

This analysis explained the GM crops appearance in the news corpus. In figure 2 it is observed that corn (maize), soybean, and canola, plus other crops like wheat, rice, and cotton appeared as mostly discussed GM crops. In Figure 2, it is illustrated that the discussion mainly revolved around corn and soybeans, thereby showing their pivotal position in the production of global bioethanol and biodiesel. Also, the crops were mainly associated with wider discussions concerning GM agricultural practices and food systems.

The media representations of these crops were not uniform. Technological advancements and environmental advantages were among the aspects positively highlighted by some reports. In the corpus, it was found that improved manufacturing processes in certain corn varieties make biofuel production more efficient. In contrast, another news report stated that oilseed crops like canola are not easily converted to biodiesel. Nonetheless, one of the crops of Canadian origin, canola, can thrive in Western North Carolina despite the fact that hardly any other crop can grow there.

Representation of Key Biofuel Crops

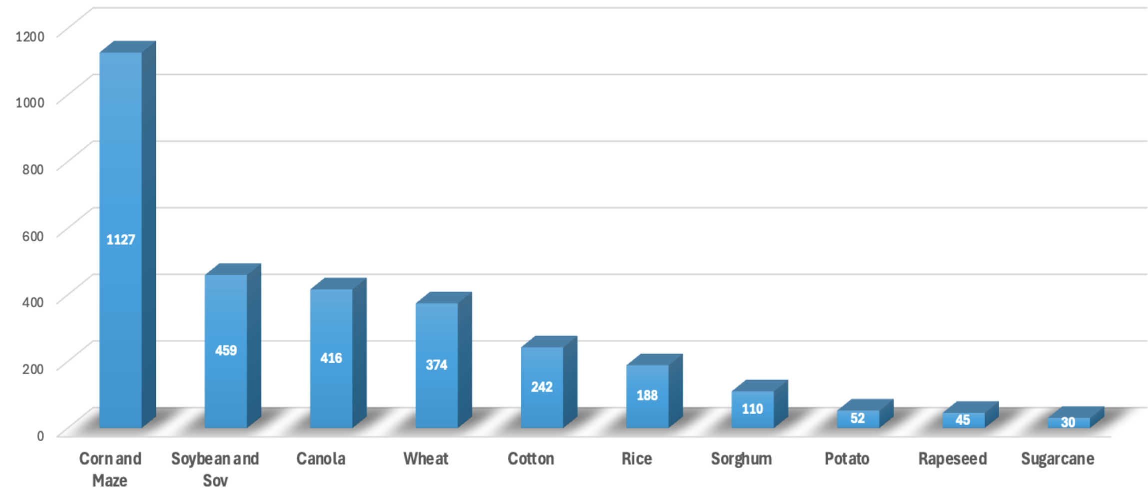

Figure 2: Distribution of Crops Across News Coverage

It further states that the use of genetically modified maize as biofuel is too risky, as such maize, which has been engineered to produce industrial fuel, contains proteins that are not normally produced in foods consumed by people. Furthermore, soybean and wheat are regarded as threats to food sovereignty because they cause dependence on foreign seed producers and harm local farmers and the health of consumers. In the corpus, GM crops for biofuel have been presented in various ways. The quotations from the news corpus are presented in *Appendix 1*.

4.1.3 Year wise media discourse on GM biofuel by stakeholder's sentiment

To analyze sentiment, this study first manually coded contexts expressing stakeholders' opinions on GMOs and biofuels across all 416 news articles. From this process, 779 relevant contexts were identified, which were drawn from 151 of the articles in the dataset. Later, those contexts were manually marked as positive, negative, or neutral based on sentiment. Although in Figure 3 the number of contexts appears to fluctuate greatly due to the variation in the number of news publications from year to year, the year-wise number of news items is presented in Figure 4.

In 2012, there were 12 news publications, and negativity (58) reached its peak. This study found that a few events occurred in 2012, such as the Occupy Monsanto protest, the EU GMO safety debate, the controversy over canola use, and the court ruling blocking GMO canola expansion for biofuel, which spiked the negativity. In contrast, in the same year, positive (27) coverage was relatively low, about half of the negative sentiment. The coverage of positive sentiment emphasized sustainability, energy diversification, and economic opportunity, focusing on GM technology to address food and energy challenges.

In Figure 3, it is shown that in the news corpus in 2015, negative (51) sentiment was the second largest by count, whereas positive (36) sentiment was the highest compared to other years. In that particular year, the criticism reflected concerns about food security, seed diversity loss, biofuel standards, and motives of gaining profit rather than addressing food or environmental needs. On the other hand, the positive sentiment expressed the potential to reduce fertilizer use, ensure water efficiency, produce more food from less land, and ensure energy security at the same time.

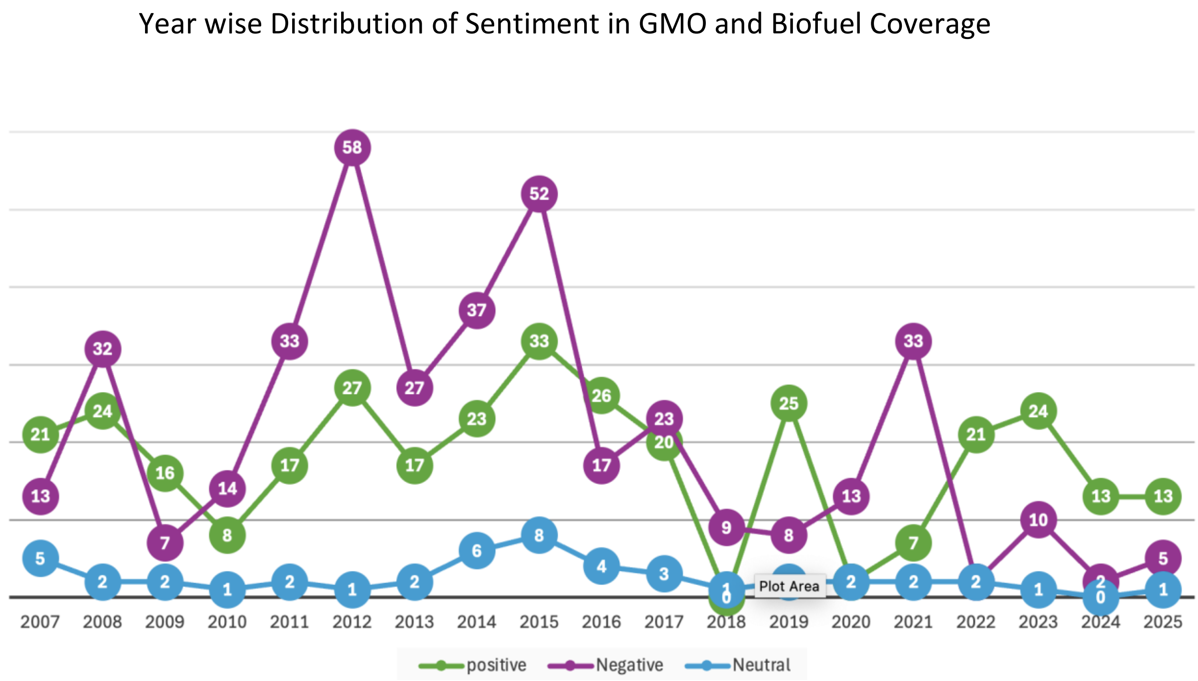

Figure 3: Year wise Distribution of Sentiment in GMO and Biofuel Coverage

In other years, the study found that positive sentiment was associated with government approvals of GM crop production in different parts of the world, promoting farmers' freedom, biofuel expansion, and arguments based on scientific evidence showing that GMOs are not harmful. On the other hand, negative sentiment was related to prohibiting GM crops, scientific evidence suggesting that GMOs are harmful, environmental issues, and food security. The key quotations from the news corpus are presented in *Appendix 2*.

Although in previous years negative sentiment outpaced positive sentiment, in recent years the scenario has reversed, especially from 2022 to 2025. During this period, discussions emphasized policy-backed GM biofuel technology, government support, economic optimism, and industrial growth. In contrast, negative discourse focused on trade and policy instability (EU tariffs, China's trade relations, U.S. budget cuts), the shift toward non-GMO soybeans and canola for producing biofuel, and questions regarding ecological safety.

Yearly Breakdown of Articles Included in Sentiment Analysis

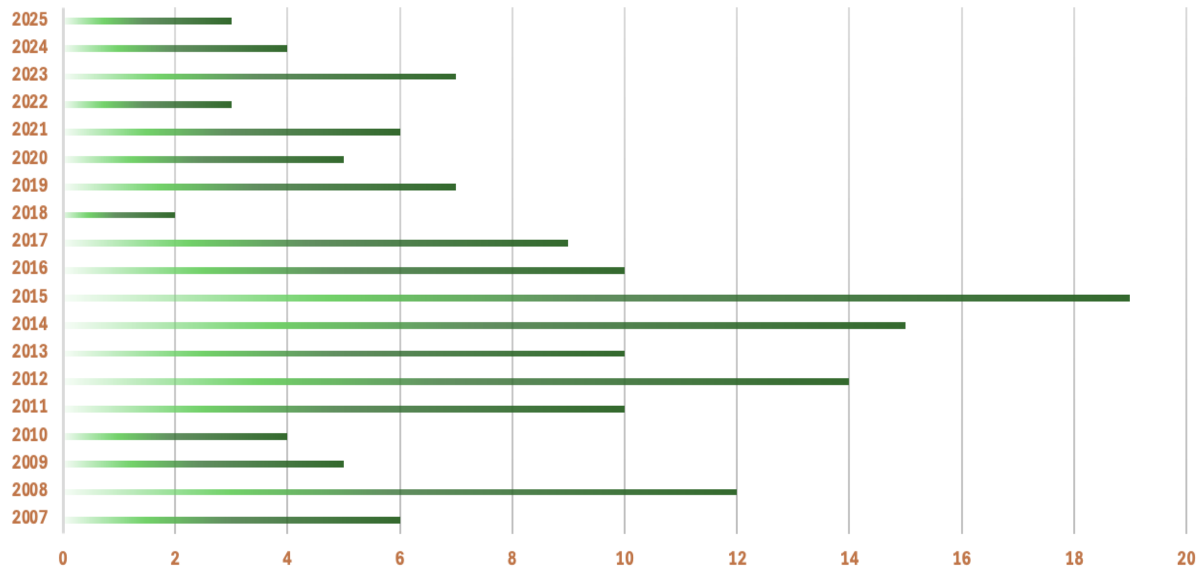

Figure 4: Yearly Breakdown of Articles Included in Sentiment Analysis

4.2 Key Stakeholders Representation in News Publications

Stakeholders are classified into three different categories: supply chain actors, where stakeholders are directly related to operations; external stakeholders, who influence operations but are not directly involved in the supply chain; and critical stakeholders, who are neither directly nor indirectly involved in operations but can influence the success of GM biofuel.

Table 1 shows that stakeholders were identified using a set of representative indicators corresponding to specific stakeholder types or keywords within the corpus. The numbers beside the representative indicators show the word frequency of appearance in the corpus, counted by NVivo 15, a qualitative text analyzer. Additionally, the frequency row indicates the total number of times the stakeholder appears in the corpus.

Frequency of Stakeholders in the News Corpus

Stakeholder Category	Frequency	Classification	Representative Indicators
Producers	1800	Supply chain actors	Farmer (1291), grower (178), producer (322), Landowners (9)
Industry Representatives	853	Supply chain actors	Company (614), corporation (78), firm (87), biodiesel plant (8), ethanol plant (48), refinery (18)
Scientific Experts	1059	External stakeholders	university (453), researcher (168), scientist (228), professor (114), expert (96)
Public and Consumer Groups	1196	External stakeholders	Consumer (428), public (400), community (180), citizen (67), taxpayer (24), villager (7)
Regulatory Bodies	914	External stakeholders	Ministry (30), minister (108), secretary (51), government (509), regulator/y (167), authority (49)
Investors	343	External stakeholders	Bank (159), loan (20), financier (40), investor (124)
Non-governmental organization (NGO)	124	External stakeholders	NGO (11), non-governmental (5), environmentalist (23), world bank (38), United Nation (47)
Business Federations	69	External stakeholders	Federation (46) , trade association (7), business group (3), chamber of commerce (5), confederation (8)
Judicial and Legal Institutions	127	Critical stakeholders	court (41), lawsuit (19), litigation (5), verdict (1), appeal (35), judge (26)
Media Reporter and Journalists	73	Critical stakeholders	Reporter (45), journalist (19), press release (9)

Table 1: Frequency of Stakeholders in the News Corpus

Stakeholder representation in the corpus is discussed below:

4.2.1 Producers

The corpus represented some of the major themes from producers' opinions on GM biofuels, such as economic prospects, environmental sustainability, technological dependency, and risks of contamination. Although GM crops are seen by some farmers as a way to achieve higher yields, diversify energy sources, and earn more income in rural areas, some farmers are worried about seed monopolies, loss of control, and environmental risks.

Producers in the U.S. and South America also show regional differences, where they focus more on productivity and innovation, while producers in Europe and smallholder farmers focus more on sustainability and local control. Those who support GM biofuel assume it will cut down fuel prices, improve efficiency, and enable the use of marginal lands. On the other side, strong criticisms have been made by organic and small-scale farmers against GM crops by claiming that they lead to genetic contamination, jeopardize certification, and consolidate corporate power. In areas such as Oregon and Hawaii, farmers especially object to GM canola, claiming that it may pollute their crops and destroy biodiversity. The key quotations from the news corpus are presented in *Appendix 3*.

Producers influence public acceptance of GM biofuel by appearing as credible economic shareholders in their regions and, at the same time, by questioning the risks associated with GM biofuel production on a larger scale.

4.2.2 Industry Representatives

In the corpus, the media represented the biofuel industry as both a driver of innovation and a controversial stakeholder. Sometimes industries appeared in the news as front-runners of technological innovation, working on large-scale GM biofuel production to ensure economic growth and sustainability. In contrast, industries were also presented as dominant shareholders who can misuse corporate power and reinforce trade inequalities.

Industries generally express support for GM biofuel technologies, such as South Korean and Indonesian collaborations for biodiesel production or U.S. grain companies funding university research facilities. Industries also highlight economic growth and job opportunities, for example, the corpus claimed that corn-based ethanol supports more than 40,000 jobs in Iowa. Nevertheless, the existence of opposing stories about non-GMO projects (e.g., Full Sun Company or Blue Ridge Biofuels) demonstrates concerns about the sustainability of local areas and consumer confidence, indicating an internal rift within the industry itself. The key quotations from the news corpus are presented in *Appendix 4*.

The public is shown to have a polarized view of industry representation in the media progressive yet cautious. The industry needs to establish public trust by adhering to corporate ethics in the production and marketing of GM biofuel on a large scale.

4.2.3 Scientific Experts

Throughout the corpus, the focus of experts includes innovation and efficiency, risk identification, the food vs. fuel trade-off, and GM biofuel policy and standards. Experts work on gene editing, biosafety, and sustainable feedstocks in order to ensure innovation and efficiency. Experts also examine risk such as ecological escape and cross-pollination. Furthermore, experts bring their opinions on land use, price effects, smallholder impacts, policy gaps, and related issues.

In the corpus, some experts highlighted improving yield, resource efficiency, reducing pesticide use on land, and promoting energy diversification. Experts also claimed that GM biofuel technology can help achieve decarbonization ambitions and strengthen the rural economy. In contrast, critical experts raised issues such as food-price inflation, distorted land use, and the unknown risks of GM crops. They also claimed that there is no possibility of reducing greenhouse gas emissions by using corn-based biofuel. The key quotations from the news corpus are presented in *Appendix 5*.

Experts' opinions have a strong influence on shaping public acceptance of biofuels; however, they can also be confusing for the public, since experts have differing opinions on GM biofuel issues, which both build trust and, at the same time, create insecurity.

4.2.4 Public and Consumers

Public and consumers in the media are portrayed as deeply divided between ethical caution and market-driven adaptation. In relation to GM biofuel, consumers and the public comprise a broad assortment of people who appear whenever there is a connection to food, fuel, land, or local jobs.

Consumers on one side are worried about food safety, ecological contamination, and corporate monopolies, and are showing their interest in non-GMO crops and local alternatives. They are also expressing anxieties such as rising food prices, land diversion, and health risks. Even if GM crops are used for biofuel, there is a chance of contamination with other organic crops, which may cause biodiversity loss. In the U.S., consumers are also demanding labeling for GMO and non-GMO crops so that they can be easily identified. Furthermore, consumers are not reluctant toward biofuel, but they prefer non-GMO over GMO, food security over biofuel, and health issues over sustainability. The key quotations from the news corpus are presented in *Appendix 6*.

Therefore, for consumers to support large-scale production of GM biofuel, it is important to ensure transparency, which includes clear labeling and GMO alternatives, as well as assurances that food prices will not be impacted, and policies that favor consumers.

4.2.5 Regulators

As with GM biofuel, the discussion surrounding stakeholders in the GM biofuel feedstock is highly centered around governments and regulators. They are responsible for approving GM biofuel policies, incentives, and trade positions, either through tariffs, bans, or negotiations. Additionally, governments act as investors in research.

Regulators can improve or restrict GM biofuel operations, such as allowing Bolivia's GM soy to supply biodiesel, U.S. officials advocating pro-ethanol trade, European legislators extending blend requirements under carbon reduction policies, Japan tightening requirements for GM imports, and South African officials opposing maize overuse. Regulators also have the obligation to implement policies and standards, set targets, and ensure consumer safety. The key quotations from the news corpus are presented in *Appendix 7*.

Regulators govern the social acceptance of GM biofuels by setting limits on what is allowed and what is prohibited. They also influence public acceptance by ensuring transparency, setting standards, and enforcing policies.

4.2.6 Investors

Investors or financial institutions, such as stakeholders, provide financing facilities to producers and industry for the construction of fuel and storage facilities, operations, and insurance. In essence, the financing criteria of these institutions effectively become the terms of financing for GM feedstocks from the field to the fuel.

The capital market activity with Malaysian linked biofuel and agri-companies can also often featured on the news coverage (e.g. raising funds exchanges in Hong Kong, Autralia and London), and it may include the investors like Black River Management, Moore Capital Management, and Sanlam Life Insurance. It is therefore possible to say that investors are growth and scale enablers. Their participation is an indication of their trust in technology and the fact that it can be profitable. Most skeptical articles though cited the danger of subsidy-based blooms, food versus fuel pressures and issues on whether investors sufficiency manage risks of land use and governance. The key quotations from the news corpus are presented in *Appendix 8*.

Investors play vital role as a stakeholder who help to shape public acceptance by giving signals for credibility and embedding protective measures. As long as they provide financial support to the project that utilize residues, waste oils or certified GM feedstocks, they authenticate biofuels as sustainable and economically viable.

Conversely, the stories which relate speculative capital to price jumps and land grabbing, contribute to the lack of untrust.

4.2.7 Nongovernment organizations (NGOs)

NGOs perform the functions of watchdogs, organizers and citizen educators. The monitoring of approval, market regulation, starting champaigns and introducing the voice of farmers and consumers to the process of policy making are the major task done by them. These NGOs have their interests in food sovereignty, land rights, biodiversity and precaution and protection against such practices as traceability, no deforestation sourcing, coexistence with non-GMO producers and meaningful community consent.

The existence of NGOs in the news corpus is primarily either in campaigning or evidence-based commentary. In Bolivia, Bolivian Platform Against Climate Change (PBFCC) held an event and 51 environmental focused organization participated in the events to express their concerns against carbon market, GMOs and biofuels. Friends of Earth Europe emphasized pollution and danger to ecology and Greenpeace was worried about the possibility of ethanol maize finding its way into the food chains. Moreover, the Oakland Institute advocated that the initiative would force small farmers out of their lives and focus on GMO maize to export biofuels at the expense of local food security. The key quotations from the news corpus are presented in *Appendix 9*.

NGOs shape public acceptance by identifying risks, raising grassroots concerns, and demanding safeguards.

4.2.8 Business Federations

Business federations and trade associations are portrayed positively in the news corpus. They have the authority to set agendas for groups of companies and influence public acceptance of GM biofuel, as they are considered advocates for practical rules and safeguards.

Business federations and trade groups such as the European Renewable Ethanol Association (ePURE), the Thai Chamber of Commerce, and the National Corn Growers

Association (NCGA) are introduced as the main promoters of biotechnology as part of an energy revolution in the modern world. They emphasize scientific development, efficiency improvement, and climate compatibility, and describe GM biofuels as a logical remedy to energy and agricultural issues. However, conflicting voices, such as Fair-Trade allies and smallholder activists, dispute these accounts, portraying these institutions as corporate interest agents capable of marginalizing farmers and destabilizing food sovereignty. In this way, business federations are portrayed by the media as forces of green innovation and icons of economic centralization. The key quotations from the news corpus are presented in *Appendix 10.*

Being stakeholders of GM biofuels, they can positively impact on the acceptability of GM biofuel to the public through mentioning economic growth, employment, investment and export potential of GM biofuel.

4.2.9 Judicial and Legal Institutions

The Judicial and Legal Institution is act as in charge of litigation and injunctions of GM biosafety, environmental risk and trade laws. It is also the authority that adjudicates disputes and investigates claims in order to give its verdict.

The judicial and legal Institution are not discussed in the corpus very often, although some examples prove their acceptance. For example, the Oregon Court of Appeals issued a stay on expanding canola planting in the Willamette Valley, which underscores judicial responsiveness to ecological risks. Similarly, the European Court of Justice ruled that crops created using NBTs should be included in the GMO Directive, indicating strong regulation. In addition, a Kenyan court has an ongoing inquiry over GM crop approvals, thus portraying courts as arenas of challenge. The key quotations from the news corpus are presented in *Appendix 11*.

Overall, the media collectively portray courts as keepers of public trust, where legal evaluations regulate the stream of corporate and policy-based growth of GM biofuels.

4.2.10 Media

The media, as a stakeholder, focus on situations in which technological development and ethical issues conflict between the hopes of clean energy and energy efficiency and the fears of food security, corporate control, and environmental risk.

There are tensions and a sense of accountability that journalists seem to employ in the presentation of GM biofuels. Several reports question the motives underlying biotechnology and portray corporations as being driven by patents and profits rather than the common good; others focus on the consequences of the food-versus-fuel crisis and the increasing prices of grains and foods affecting the global population. Nevertheless, innovation is also embraced by reporters presenting algae-based fuels and synthetic biology fuels as more ethical and cleaner options. The key quotations from the news corpus are presented in *Appendix 12*.

In terms of public acceptance, the media draw attention to corporate domination, food insecurity, and environmental destruction, lending criticism toward GM biofuels. However, discussions about cleaner and less-GMO biofuels or science-based innovations create selective reassurance toward biofuel technology in general.

4.3 Map of Dominant Narratives and Frames on GM biofuel

This section presents the dominant narratives and frames developed from discussions in the news corpus. By analyzing the media texts, several themes have been identified. Through the combination of these discursive features the themes have been categorized into supportive and critical discourses to GM biofuels. This gives the summary of the framing trends, which have an impact on the stakeholders and acceptance of GM biofuels by public.

4.3.1 Supportive Discourses and Frames

The corpus displays GM biofuel in diverse desirable perspectives highlighting the economic, environmental, technological and systemic benefits.

4.3.1.1 Energy security & decarbonization

In this study, it is found that media coverage often mentioned that GM biofuel can be a solution to energy security and decarbonization. In the discourse, it is stated that renewable ethanol and biodiesel derived from agricultural feedstocks offer cleaner and more secure energy.

GM feedstocks such as corn, soy, and wheat are consistent raw materials that can be used to produce ethanol and biodiesel on a large scale to support blend policies such as E10 and E15 (the percentage of biofuel mixed with petrol). It is also mentioned that E10 works in nearly all petrol cars on the road. In addition, the use of biofuel will reduce dependency on imported fossil fuels, as locally produced biodiesel and ethanol can ensure national fuel self-sufficiency.

The media further state that liquid fuels have been used in transport for decades, thus providing an opportunity to cut emissions through renewable ethanol and biodiesel. In the corpus, renewable ethanol is presented as a solution for decarbonization, which is already making progress. Moreover, Ireland's Biofuel Obligation Scheme is explained as a vital policy (blending a certain percentage of biofuels with traditional fossil fuels) that increases the use of biofuels and decreases carbon emissions. The key quotations from the news corpus are presented in *Appendix 13.*

4.3.1.2 Economic Growth

In the news, GM biofuel is portrayed as a means of economic development through job creation and global trade opportunities. Some of the economic gains described in the corpus include increased yield and productivity, assured sales to processing plants, and surpluses that can be exported to earn foreign exchange. There are also revenues of co-products, animal feed and glycerin.

In the data, the main proponents of this development discourse are business federations, producer associations and refining companies. Such federations as the CEPB in Bolivia openly celebrated when GM gave approvals claiming that it was a great move towards the direction of biofuel development and agro-Industrial competitiveness. Another aspect suggested to form industrial partnerships is illustrated by new plants and refineries that create job opportunities and establish connections with export channels. Other organization including the Association of Kenya Feed Manufacturing (AKEFEMA), would claims that lift of the GMO bans would contribute to the reduction of the feed price and save other jobs in connected livestock and feed industries.

The media discourses are inclined to accentuate regulatory approvals, financing plans, plant investment and some statements about employment, earnings and exports. The corpus underlines economic benefits in the form of strengthening the agro-industrial sector to produce more biofuels and localizing employment opportunities in areas such as Santa Cruz. Even where there is legal or trade uncertainty, such as in Kenyan court decisions or tariff instability, the supportive stories emphasize that GM biofuel provides a cushioning effect, revenue diversification, and a means to connect rural economies to long-term and predictable demand. The key quotations from the news corpus are presented in *Appendix 14.*

4.3.1.3 Innovation and efficiency gains

This framing of innovation and efficiency gains encompasses three recurrent processes: process innovation, agronomic innovations, and novel feedstocks. In the corpus, process innovation is related to engineered yeast and microorganisms that enhance yields of ethanol or butanol while reducing energy and water use; agronomic innovations refer to traits that maintain reliable outputs of oilseeds and starch, such as those related to drought or herbicide resistance; and novel feedstocks involve gene-edited winter oilseeds like CoverCress or engineered photosynthetic organisms.

There is corpus-based evidence that supports such framing through certain approvals, statistics, and laboratory results. For example, regulators approved GM Saccharomyces strains to ferment ethanol, and ePURE successfully produced 5.6 billion liters of ethanol and 5.33 million tons of co-products in the EU in 2019. This articulates the innovation and efficiency gains. The coverage also highlights technological innovations such as S2B technology aimed at the direct synthesis of butanol, synthetic biology for reengineering genetics, the use of genetically modified photosynthetic microorganisms, and advanced natural (nano) materials.

Furthermore, governments have emphasized the need to enhance innovations in agro-industry and achieve efficiency gains. Argentina's approval of genetically engineered yeast strains for industrial bioethanol is cited as providing a strong framework for industrial bioethanol in this respect. These are then translated into tangible, quantifiable increases in performance by universities and research institutes, and the message is reinforced in the media that GM-related biofuels represent smart engineering that results in efficiencies rather than a high-risk speculative technology. The key quotations from the news corpus are presented in *Appendix 15.*

4.3.1.4 Co-products and circular bioeconomy

In the corpus, a strong focus on co-products and the circular bioeconomy narrative is mentioned to support GM biofuel technology. It is conveyed that GM biofuel is not merely a fuel source but a whole-plant system—for instance, oil conversion into biodiesel or renewable diesel, remaining distillers' grains turned into animal feed, glycerin finding industrial applications, and even used cooking oil being injected into local biofuel streams. The point is that consistent GM crop yields also result in consistent refining and crushing processes and, consequently, co-products that have a constant flow. Such co-products lower feed costs, generate revenue for rural industries, and ensure that value is circulated within local economies.

After conducting such framing, numerous views have been noted on GM access in the feed industry within Kenya about the quality of feeds and local fuel production. The decision will have the effect of lifting the ban to facilitate local production of biofuel using low-cost GMO feeds and producing nutritious soluble that will enhance the quality of feeds. Producer's reports have been used in Bolivia to correlate GM approvals with a rise in the supply of vegetable oil, one of the key inputs in the manufacturing of biodiesel. University refinery alliances facilitate this system-based approach implying that processing experts and understandings can enable processors to develop systems that enhance processing performance.

On the fundamental level, investment notes also refer to U.S. feed mills which now have facilities of specialized biofuel co-products research. This is commercialized by the market reports that follow spot negotiations on prices of soybean meal (290–300/t) to put the emphasis that co-products are not waste but rather significant monetized products in the biofuel value chain. The key quotations from the news corpus are presented in *Appendix 16.*

4.3.1.5 Trade access and competitiveness

The news discourse has also brought trade access and competitiveness as some of the positive factors that influence the scaling up of GM biofuel. It also focuses on the fact that the decrease in tariffs, reduction of tariffs, the liberalization of the importation GM feedstocks, and guaranteed export corridors will give producers a chance to enter larger markets and sell their product in better prices so that their refineries will be able to operate at maximum capacity. In the meantime, the positive news of supportive reporting is that clean fuel policies that increase biodiesel demands to stabilize both demand and prices render GM feedstock supply chains to be more competitive in the globe market. These are represented as growth of gross exportation, foreign exchange earnings, and creation of employment with respect of processing plants.

The producers and trade associations, government officials, and corporate alliances along with the agro-industrial chain are the key players in the supporting this narrative. Farmers such as ANAPO and CEPB are expecting GM approvals to create surpluses to export and increase foreign exchange earnings and give biodiesel feedstock. It is also reflected by legislators and trade officials who call on the necessity to make the export of ethanol more competitive and protect local producers. Companies offer existing cross-border joint venture as a method to develop their business and enter new market, i.e GS Caltex, biodiesel plant of Posco in Indonesia. For feed manufacturers, as input users, GMO import regulations appear as tools to reduce costs, and the lifting of bans would result in a reduction in feed prices by up to 30 percent, supporting the competitiveness of soy biofuel value chains.

Regulatory action and market outcomes influenced by pure competition are often interconnected in such news. Headlines are filled with terms such as limitation easing, export competitiveness given priority, or business expansion, anchored in developments in key markets like Bolivia, Brazil, Indonesia, and Kenya. Therefore, the consistent focus on policy change and market response develops the view of a clear anti-trade barrier storyline. GM biofuels are less competitive in terms of market demand and the development of clean fuel caps and plant investments when barriers are imposed on GM feedstocks. Besides, they are able to produce exports, increased foreign exchange and rural industrialization. The key quotations from the news corpus are presented in *Appendix 17.*

4.3.1.6 Summary of supportive framing

The news portrays GM biofuels as viable, effective, and socially desirable solutions that extend beyond fuel production to advance wider economic and environmental value of benefits. Instead of abstract theories and speculations, the coverage relies on actual, result-based examples of CM biofuels to reach higher rural earnings, reduce expenses and recycling plants to illustrate how GM biofuels can be the contributors to rural income, jobs, exports, and supply chain reliability. It establishes a long-term association among innovation, policy and investment and their concrete results and gives GM biofuels a rational tool of energy security and decarbonization which may be implemented as a sustainable circular bioeconomy.

4.3.2 Critical Discourses and Frames

The corpus represents GM biofuel from various critical angles. The news strongly criticizes GM biofuel and points out environmental, social, and governance issues.

4.3.2.1 Deforestation and land-use change

From the news, it is found that framing across different sets of publications is consistent. The growth of GM feedstocks for fuel implies frontier expansion, the transformation of forests and grasslands, as well as smallholder plots, into monocultures. Other news also reported that such mechanisms only serve to camouflage rather than alleviate the real problem. Specifically, one Bolivian environmental group was quoted as saying that GM events, such as the introduction of biofuel crops like HB4 soy, could lead to more deforestation and changes in climatic cycles.

Moreover, several articles indicated that the increasing demand for soy, for both animal feed and biofuel, has been one of the causes of deforestation and the invasion of large-scale production lands into indigenous and smallholder farming systems in Brazil and Argentina. In addition, GM biofuel crops and trees pose risks of increased pesticide use. One recurring narrative throughout the coverage is that, despite GM characteristics improving yields or resilience, growing demand from fuel markets would still result in more land under cultivation, thus requiring land-use shifts from forests and community lands.

Furthermore, the narration of such stories in the news matters. Deforestation or any type of indirect land-use change is not presented as something occurring in the distant future or as an abstract possibility but rather as a very real short-term threat with clearly perceived mechanisms. Strict safeguards such as no-deforestation regulations, ILUC responsibility, protection of indigenous rights, and clean emission monitoring all face doubts as expressed in the corpus. The key quotations from the news corpus are presented in *Appendix 18.*

4.3.2.2 Biodiversity, contamination and gene flow

It is claimed in the news corpus that GM crops for biofuel carry the risk of reducing biodiversity through contamination and gene flow with other natural seeds and plants. In news publications, critics say GM plants can pollute nature and interbreed with other plants, spreading to neighboring fields. Seed growers in Oregon also warned about the behavior of canola, claiming that it acts as a weed and has the ability to pollute vegetable seeds and other non-GMO canola. It was also mentioned in the news that using genetically engineered microbes and trees for biofuel could pose serious long-term risks to biodiversity.

The corpus evidence includes contamination incidents, professional evaluations, and regulatory precautions. The ETC Group mentioned that “GM crops have outcrossed after we were told they wouldn’t” and stated that “GM bacteria for transforming crops into biofuels have been proven to cause soil damage.” Media reporting on the decision by the Court of Appeals to stop canola expansion in Oregon was perceived as institutional acknowledgment of the risk potential of gene flow and the threat of weed infiltration in a high-value seed area. Indeed, some scientists and NGOs accentuated doubt and said that multiple experiments have already demonstrated that GMOs have negative effects; no one can say with confidence that GMOs are safe.

Moreover, several news accounts explicitly connected biodiversity and gene flow issues to production zones and practices. For instance, it was repeatedly mentioned that in the highly sensitive Willamette Valley seed market in Oregon, contamination could become the most immediate threat; even a trace of GM presence can affect certification and trade policy. The issue was grounded by courts, farmer coalitions, and local contexts; therefore, reportage made the threats believable and vivid to readers—livelihoods, export markets, and ecological integrity were all under threat. The key quotations from the news corpus are presented in *Appendix 19.*

4.3.2.3 Corporate power and seed dependence

Environmental NGOs, social movements, consumer advocacy bodies, and farmers mostly questioned the corporate power and seed dependence associated with GM crops for biofuel. These stakeholders shared a common narrative: GM biofuel pathways lead to greater reliance on proprietary seeds and corporate-controlled inputs and therefore consolidate power over land, pricing, and technology. The Rural Women’s Assembly of Southern Africa rejected GMO projects and biofuels, questioning the broader contest of food systems by corporations and speculators. These stories repeatedly connected biofuels with the firms and structures of hybrid and GM seed trade, expressing fears that such companies and varieties could deepen dependence in rural economies if GM feedstocks for fuel became more widely used.

In media discussions, the structure of the seed industry, intellectual property regimes, and firm behavior were all cited. It was emphasized in numerous proceedings that the economic concentration of the seed industry, aided by gene patenting, has limited access to seeds through licensing contracts and prevented peasants from saving seeds. IP-based seed market enforceability was singled out by political commentary in Argentina, which cited Monsanto's past lawsuits against farmers, as well as criticism of companies once branded as "octopuses" in oil and export markets (Cargill, Bunge, Dreyfus, and Glencore). Another voice among consumers warned that definitional loopholes in regulation could allow engineered organisms to evade oversight, reinforcing fears that lax regulation combined with corporate strategies would increase dependence undemocratically.

The media intertwined stories about seed IP, market concentration, and biofuel demand as sources of corporate power. With GM traits being approved in fuel crops, the range of available seeds narrows, license costs rise, and market control becomes centralized among a small number of conglomerates that also trade and process crops. The direct language of food sovereignty, corporate takeover, and similar themes rendered the issue understandable and relevant to broad audiences, placing it alongside personal interests like farmer control, input prices, and biofuel policy benefits. This framing was shown to reduce public acceptance unless visible counterbalances existed, such as competition in the seed market, protection and liability measures for farmers, open pricing, research for the common good, and clear regulations covering all GM techniques. Skepticism was mitigated when such safeguards were mentioned; however, it remained strong and persuasive where absent. The key quotations from the news corpus are presented in *Appendix 20.*

4.3.2.4 Carbon markets and "false solutions"

Most critical views on carbon markets and genetically modified (GM) biofuels in the news come from grassroots and rights-based actors, mostly from Latin America and

Africa. Environmental platforms in Bolivia, women's movements in Africa linked to COP processes, and indigenous rights advocates consistently consider these mechanisms a false solution to the climate crisis. Their arguments focus on the expansion of carbon markets coupled with GM biofuel growth, which turns forests and farmland into commodities, justifies offsetting rather than reducing actual emissions, and takes control away from local communities into the hands of corporate buyers or certifying entities. Specifically, Bolivian platforms maintained that the allowance of biofuels based on imported GM ecotypes has encouraged deforestation, disrupted climatic cycles, and pressured native leaders to transfer forest rights to facilitate the commercialization of environmental operations of "Mother Earth." African women's movements also oppose participation in carbon markets, GMOs, and biofuel production, presenting them as exploitative systems that open new avenues for land and resource appropriation.

These grounds of criticism are frequently given a false appearance of legitimacy by journalistic and other media accounts, since they are caught in land-use contradictions and modern policy trends. The South American news has focused on highlighting that Brazil and Argentina have engaged in the cultivation of soybean that has led to the increased of the animal feed and biofuels globally, increased demand has resulted in the rapid deforestation of the land as well as the destruction of the indigenous and small-scale farming systems. In Bolivia, the contextualization of report is done concerning recent GM authorizations for fuel production and certification producers which are said to pressure community leaders to abandon forest rights. Such framing beings an African media an even broader sense of injustice and carbon market and GM biofuel are perceived as a source of resource grabbing, land and seas degradation, and loss of community sovereignty. This discussion is based on territorial needs, livelihoods, and land tenure that is based on particular material realities and not abstract technocratic patterns, and therefore such critiques are credible in popular discourses.

The implications of this framing are severe tor media discourse as well as the perception of the population regarding carbon markets and GM biofuels. News reporting politicizes and makes the story tangible by attributing actors, places, and processes such as soy frontiers in South America, certification firms in Bolivia, and forest concessions. Headlines featuring Deforestation, Land Rights, and Sovereignty compel audiences to reconsider carbon market programs not just in the context of climate but also in terms of social and distributive effects. Therefore, in the coverage under analysis, the social acceptance of GM biofuel pathways appears conditional upon maintaining no-deforestation feedstock requirements, accurate accounting of indirect land-use change, open monitoring and verification beyond offsets, and the provision of community consent and benefit sharing. In the absence of such protective measures, the argument that these mechanisms represent false solutions remains potent and continues to sustain skepticism and apprehension regarding the expansion of carbon trading mechanisms associated with the development of GM biofuels. The key quotations from the news corpus are presented in *Appendix 21.*

4.3.2.5 Water use, pollution & eutrophication

Throughout the reviewed materials, issues concerning the use of water, pollution, and eutrophication are among the hot points for those who are staunchly against GM-related biofuels. NGOs, ecosystem reporters, community leaders, scientists, and consumers keep stressing the pressure that GM biofuel feedstocks exert on freshwater systems and soil. The principal allegation repeated through all reports is that large-scale cultivation of GM crops and the use of engineered enzymes or microbes in processing "consume more energy than they produce, and therefore cause more air pollution, soil and water depletion, and pollution." The particular risks highlighted in the readings are fertilizer leakage, eutrophication, and waste disposal in processing factories. At the beginning of the talks about the so-called bio-based economy as a Trojan horse for the acceptance of GMOs, the risk framing featured in the picture included water and biodiversity destruction, deforestation, and animal welfare. Other reports later associate the expansion of GM biofuel with drought stress, depletion of local aquifers, and disputes related to access to water by communities, thus placing the issue of water impacts at center stage as a point of contention.

Hydrological risk narratives are reinforced by media representations countering technological optimism. New GM feedstocks, enzymes, and yeast articles are frequently accompanied by opposing statements from local communities and pressure groups. Newspapers in water-desperate regions also feature communities debating that economic development should not be founded on biofuel crop exports or water trusts, but rather on food sovereignty and local production. These stories are blended with allegations of GM biofuel causing unaffordability of water and political manipulation, fears of unhealthy GM pathetic food and pollution of the transportation system. The issue of women as vulnerable is specially mentioned in regional reports from Bangladesh which explains how conversion of land to biofuel crops raises water burdens and affects food security. Such media representations made a clear discourse by introducing living characters into the frame in opposition to GM biofuel projects, freshwater access, water quality and community ownership of natural resources.

The arguments on which these concerns are argued is a combination of advocacy testimony, professional commentary, and regulatory analysis. Among the reports, references include organizations such as the National Family Farm Coalition, which at a conference called “BioETHICS 2006” argued that the expansion of ethanol production causes soil erosion and water pollution. Drought cases in communities of drought-stricken regions uphold arguments for commons water management, and more recent media events point to gaps in policies regarding gene-edited or novel GM feedstocks such as herbicide-tolerant canola and biofuel-specific switchgrass. It is feared that with no comprehensive regulatory framework in place, potential runoff impacts, herbicide residues, and effluents remain unaddressed, thereby externalizing water risk. Even articles that offered positive consideration to biofuel technologies themselves recognize the dilemma that without monitoring and precautionary regulations, these water-use impacts, along with eutrophication from GM biofuel, remain unresolved. Thus, water is not only a variation of the environmental variable presented in the media corpus but also a governance and justice issue that constitutes a critical frame to GM biofuel expansion.

Therefore, the news has pointed out a variety of critical viewpoints regarding GM biofuel, mainly revolving around environmental, social, and governance matters. Environmental NGOs, local scholars, community supporters, and farmer unions who are against GM biofuel crop expansion characterize it as a cause of deforestation and land-use change, a threat to biodiversity through gene flow and contamination, and a factor that increases dependency on corporate-controlled seeds. Carbon markets and certification validation are described as false solutions transferring power to corporations, while water and soil risks are used to emphasize local environmental effects. The key quotations from the news corpus are presented in *Appendix 22.*

4.3.2.6 Summary of critical framing

Therefore, the news has pointed out a variety of critical viewpoints regarding GM biofuel, mainly revolving around environmental, social, and governance matters. Environmental NGOs, local scholars, community supporters, and farmer unions who are against the expansion of GM biofuel crops characterize the latter as causes of deforestation and land-use change, as well as threats to biodiversity through gene flow and contamination, and as a factor that increases dependency on corporate-controlled seeds. Carbon markets and certification schemes are depicted as “false solutions” that transfer power from communities to corporations, while water and soil hazards underscore local environmental impacts.

4.4 Tensions form between stakeholder groups

In the corpus, it is noticed that different stakeholders have different standpoints in terms of GM biofuel acceptability. Due to differing points of view and priorities, tension is observed around food security, energy security, unseen risks, innovation, profit-seeking tendencies, loss of biodiversity, and so on. This study examines the stresses that arise at different times over various topics related to GM biofuel and discusses the analysis and findings below.

4.4.1 Food vs Fuel

Biofuels often attract the Food vs. Fuel debate and assume that food prices would rise or that land used for agriculture to meet food demand may be reduced to meet the requirements for producing GM crops for biofuels. According to News Nation Bangladesh (2016), World Bank President Robert Zoellick claimed that biofuel is a significant contributor to rising food prices. At the same time, The Guardian cited the World Bank as blaming biofuels for "global food prices up by 70%." However, the Development Prospect Group found that biofuels' effect on food prices is not as large as thought, stating that more than 88% of the rise had other causes than biofuels, and claimed that increased oil prices were responsible for the rise from 1997 to 2004.

On the one hand, regulators assume that gene-edited organisms, including yeasts or algae, can increase the yield of ethanol in a cost-effective manner and generate co-products for animal feed. However, critics argue about the risks of contamination, overuse of land, and dependency on corporations. On the other hand, this rift manifested politically in Argentina during the approval of GM Saccharomyces cerevisiae for corn ethanol, where authorities embraced the scientific view that the organisms posed no additional agroecological risks, while civil society bodies warned about higher food prices and the risk of food chain contamination.

News media frames differ for GM biofuels depending on the institutional and sectoral location of the media organization providing the news. The Secretariat of Agriculture of Argentina claims to have introduced GM yeasts as one of the frameworks to produce ethanol and feed, yet industry representatives perceived the approval as a crucial move in the direction of competitiveness. Scientific advisors paid more attention on safety and trade-offs, stating that GM foods do not invariably pose greater threats than conventional foods, but they also claimed that land used in the production of fuel reduced the land available to produce food. NGOs raised concerns about cross-pollination and contamination in Uganda, as well as possible soil impacts from GM bacteria.

Based on the news, the public appears to entertain concerns about whether institutional assurances may be deemed credible and whether they are proportionate to the level of deployment of such technology. Media coverage showing that Oregon scientists advised the community of the potential for GM canola to result in irreversible gene dissemination, or that Canadian data confirmed contamination in nearly 97% of seed lots, are instances of this doctrinal stress. The food-for-fuel controversy is another matter that leads to further resistance; Greenpeace argues that maize ethanol pushes food prices higher, while feed producers argue that co-products might aid in reducing imports of protein but are being blocked by GMO regulations.

It is indicated that trust is built when benefits are concrete, visible, and attached to highly esteemed governance institutions. In Argentina, the fact that explicit references to oversight bodies, including CONABIA and SENASA, were made during the approval of GM yeast reinforced the sense of legitimacy because the decisions were associated with national institutions. The resistance accumulates because expenses are charged to the groups not directly benefiting by the implemented policy changes which can be a farmer who have suffered damage due to seed drifting or the communities who have suffered due to the policy changes. This similarity between these stakeholders is that biofuel pathways will result in increased dependence on proprietary seeds and corporate-controlled inputs, which will centralize control over land, pricing, and technology.

The findings suggest that GM biofuel may not be a controversial practice because it will be approved depending on the quality of governance and distribution of risks and benefits. Applications that are well-contained, independently certified, and create tangible local value are more likely to be accepted as innovations. When oversight is obscure, deployment is diffuse, or when gains are mainly enjoyed by a few shareholders, the risk narrative takes hold. Therefore, wider acceptance may be expected based on robust containment, the publication of clear evidence of co-benefits, and precautionary measures to remedy harm. It appears that this balance between innovation and caution is the critical element in determining the social license of GM biofuel. The key quotations from the news corpus are presented in *Appendix 23*.

4.4.2. Innovation vs precaution in GM biofuel

The news coverage usually falls under two contrasting perspectives of innovation and precaution when it comes to debating GM biofuel. Industries and farmer groups, situated in a very precarious position, may try to promote GM crops and modified yeasts as serious tools to enhance yields and reduce costs in competitive renewable energy markets. Beyond this horizon, other civil society-oriented shareholders, some independent scientists, and cautious policymakers begin to focus on uncertainty and environmental hazards combined with socio-economic factors that require additional restraint before deployment on a massive scale. This framing conflict influences the perception of public on the topic; GM biofuels are regarded as the tool of sustainable development or the experiment with uncertain and even negative results.

Innovators who are supported by discourses that encourage modernization in agriculture and efficiency in industries have invented GM biofuels. Argentinian government cited the fact that it had accepted genetically modified yeast as an actual guideline to the development of ethanol production and animal feed. In the meanwhile, the representatives of farmers remarked that the concept of biotechnology enables them to address the growing in the world and act sustainability with the help of digital tools. Such optimism has been quite likely to be criticized in the field of warning. As example, a farmer in Missouri said that in case Mexico would ban on GM corn, it would decrease the price of biotech crops showing how a regulatory shock on a global scale could alter the agricultural markets.

The precautionary arguments are concerned with ecological security, food security, and sovereignty over the seed systems. Opponents see GM yeasts and GM crops, however productive the production, as a factor that puts farmers at the mercy of multinational corporations and whose side effects on the environment have not been seen before. Scientific arguments aside, cultural and political arguments also exist that production of biofuels can lead to land being used in food production rather than biofuel production and that it leads to the loss of biodiversity. Industry has attempted to refute these claims with obvious cases such as ePURE stating that ethanol supply plants produce millions of tonnes of GMO-free animal feed in Europe. These stories reveal that resistance is grounded not on what seems dangerous but also on more general distrust towards corporate domination and regulatory capture.

The adoption of GM biofuels within society is influenced by the dynamics of a changing balance between the discourse of innovation and the discourse of precaution. Favorable news about Argentina records the approval of yeast as a crucial matter of national interest regarding energy security and economic development. On the other hand, events like the GM ban corn in Mexico draw attention to perceived risk to the livelihoods of farmer by such policies and therefore undermining public confidence. The dichotomy has been adopted uneasily with enthusiasm being located in producer states, where policy and the industry focus on economic advantages, while skepticism is stronger and more vocal in environmentally conscious and consumer-focused environments.

Furthermore, the innovation versus precaution divide has developed within a larger struggle of values, trust, and decision over the future of agriculture. Innovation frames focus on modernization, competitiveness, and efficiency, which are primarily supported by governments and industries. Precautionary frames, on the other side, are preoccupied with the ecological threats, financial vulnerability, and ethical concerns and insist on adequate protection prior to the large-scale implementation. It is this coexistence of stories that put GM biofuels at the center of debate, as seen both as a magnificent move towards sustainable energy and as a technology with uncertainty and has yet to be fully evaluated. The key quotations from the news corpus are presented in *Appendix 24.*

4.4.3 Capital scaling vs social justice in GM biofuel

The global GM biofuel push is portrayed in news coverage not only as a technological and scientific story but also as a financial one. On one hand, investors, multinationals, and governments seem to side with bankers in arguing that GM biofuel technology development requires investment for commercialization and access to foreign markets. Civil societies, small farmers, and social justice activists unite to oppose export-oriented energy markets at the expense of food security and local livelihoods. In this way, the discussion presents the tales of billions of liters of effective ethanol and global competitiveness versus the tales of equity, access, and community sustainability.

Financial market voices in the news regularly describe GM biofuels as investment-ready opportunities. Listing abroad was reported by some companies, such as Mission Biofuels Ltd and GMO Ltd, as a way to attract foreign capital, where early-stage firms sought investors with a higher risk appetite. The regulatory approval of GM yeast to produce bioethanol in Argentina was seen by the industry as a significant advance toward the competitiveness of the corn ethanol sector. On the Contrary, Greenpeace was against this capital-based growth and claimed that GM maize ethanol was unsustainable form of bioenergy that increases food prices and could destabilize poorer populations.

In the news coverage, it is observed that the same issue of big scale production and social justice repeatedly appears. Investors want to do business globally and emphasize the foreign trade, whereas farmers are afraid of losing their control on seeds and all. In Uganda, critics warned that, farmer’s ability to reuse seeds from previous harvests may affected if GM corn introduction for biofuel is introduced. Also, critiques across Africa described biofuel linked projects are worsening the inequality between rich and poor farmers while simultaneously degrading the ecosystems. These all demonstrate that the discussion extends beyond technological outputs and focuses instead on structural matters specifically, winning and losing from biofuel production.

In the news, there is also an instance of how perceptions of fairness, accountability, and not technical performance make people trust them. Planting the unapproved GM wheat in the U.S. fields also caused the suspension of imports in Japan and South Korea, and renewed the zero-tolerance of the EU, another issue that raised even more concerns about corporate responsibility and regulation. On the same note, the approval of GM yeasts in Argentina also came with a rich dose of scientific evaluation and the assurances that the byproducts of the GM products were safe to feed to animals-issues that were referenced to bolster the legitimacy aspect amongst the stakeholders.

It is also reported that attempts have been undertaken to relate scaling with tangible social co-benefits in different news sets. Trade associations like ePURE pointed out that besides the production of ethanol, biofuel plants were also manufacturing millions of tons of high-protein, GMO-free animal feed and biofuels is a two-fold solution to energy and food production. This framing attempts to transform a narrative of marginalization into one of mutual gains. Industry shareholders sought to reduce opposition by emphasizing outputs that benefit farmers and food systems and by demonstrating that large biofuel investments can offer more than short-term profit.

The news material collectively presents a wide range of issues in GM biofuel discussions shaped as much by economics as by technology. While scaling is promoted by governments, firms, and investors as a path toward competitiveness and economic growth, civil society organizations and farm lobbyists highlight problems of equity, food security, and sovereignty. The acceptance of large-scale projects by the public therefore depends on the extent to which they can demonstrate fairness and inclusiveness in addition to technological advancement. The key quotations from the news corpus are presented in *Appendix 25.*

4.4.4 Trade competitiveness vs regulatory sovereignty in GM biofuel

News stories on GM biofuel demonstrate the competition between trade and regulatory sovereignty. On the one hand, biofuel-exporting countries and business associations, which advocate for free markets and the removal of trade barriers, argue that economic competitiveness is promoted through the standardization of international rules and the elimination of limitations on GM feedstocks. This struggle represents the essence of GM biofuel being at the frontier of economic globalization and national self-determination. On the other hand, governments and regulators, represented by their sovereign power, impose strict GMO policies based on environmental protection, consumer safety, and ethical grounds. This tension illustrates how GM biofuel sits at the crossroads of commercial growth and domestic law.

Throughout the news, industry representatives and trade groups have argued that regulations are hurdles of fair competition. It is reported that trade alliances in the U.S. criticized EU regulations on GMOs because they limit their exports of corn, soy, and refined goods in an incompatible way in international trade. Similarly, soybean and GM biofuel associations pushing EU to enter the market to gain better trade access. In contrast, European officials defending their sovereignty by issuing strong statements during the TTIP negotiations, mentioning that the EU would not negotiate on GMOs or related agricultural standards. This type of statement has big impact on public acceptance of GM biofuel.

When biofuel trade clashes with strict political or environmental policies, various conflicts intensify. For instance, Brazil’s ethanol tariff and Mexico’s ban on GM corn have been criticized by the US lawmakers by saying it discriminatory and detrimental to American producers. Maxico justified such ban is necessary for health and sovereignty. Following the same manner, EU has the restriction too and criticized by American agri-media too. This signifies the conflict of interest in trade competitiveness and regulatory sovereignty.

The news corpus underlines that the argument has implications far more insightful than policy and trade, it cuts across popular ideas of legitimacy, and justice. Regulatory sovereignty is more likely to strengthen domestic trust, for example, Ireland on GM crop refusal due to the risk of contamination issues, whereas the exporting country showed frustration for limited market access. On the other hand, this restriction can be explained as consumers protection from the harm of GM crops and GM biofuel. Ugandan scientists have stated that GM corn will be allowed in biofuel value chains but not in the food market reflecting interdependent power of sovereignty, consumer safety and national control.

It is necessary to have balanced competitiveness and sovereignty by means of flexible yet supportive governance structures. Though the World Trade Organization has the power to resolve disputes, tensions always arise whenever the sovereignty of a state is compromised. Other news items mention dual-track strategies that may be a potential compromise where exporters practice open measures and strive to achieve maximum co-benefits, for example, feed animals on products or minimize greenhouse gas emissions and the importers remain free in their decision-making on approvals. Another example can be the authorization of trace levels of non-approved GM events by the EU Standing Committee, albeit evaluated by EFSA, on the imports of feeds yet, it is still a politically sensitive issue.

Lastly, this news sets make GM biofuel trade a larger paradox of global government where the advantages of trading competitions through unity and free markets are combined with regulatory sovereignty as the source of accountability and democratic legitimacy. Exporters and members of the industry consider GM biofuel restrictions as protectionism and governments and consumers consider them as essential protection. The key quotations from the news corpus are presented in *Appendix 26.*

4.5 Stakeholder’s Policy Perceptions

Different stakeholders’ view has been portrayed in the news corpus on the GM biofuel policy and regulations. To describe the stakeholder’s policy perception this study has focused on certification and standard, international agreement and regulatory policy. In the corpus it is found that the policy and standard are complex governance system. In this light, the media serves as an intermediary platform where three elements science, policy, and public perception intersect and influence stakeholder’s interpretations regarding the GM biofuels acceptability.

4.5.1 Certification and standards

The main issue in the acceptance of GM biofuel is the certification and biosafety approval systems. Across the media landscape, it is observed that trust in this technology does not solely depend on technicalities of the gene engineering process but on the existence of visible institutional checks and balances. The South American round tables on biotechnology include the Argentine Servicio Nacional de Sanidad y Calidad Agroalimentaria (SENASA) and Comisión Nacional Asesora de Biotecnología

Agropecuaria (CONABIA); the South African Roundtable on Sustainable Biomaterials (RSB); and their European equivalents, such as the European Food Safety Authority (EFSA), which act as sources of credibility. Their mere mention creates a sense of control signaling that a system exists to monitor and regulate.

Authorities tend to use certification as a means of communication or protection. The news articles report that Argentina was the first country to authorize the use of GM yeast to make ethanol and the news was announced with the word through presenting impeccable scientific tests. The authorities emphasized the idea that SENASA did not find this strain dangerous anymore in the agroecosystem and considered it suitable to be used in animal consumption. Certification as the one that instills the scientific approach and trust in the population is introduced by such pronouncements. Hence, GM biofuel will be validized at the domestic and global front through certification since debates are ongoing that state intervention is the sole assurance of accountability, safety, and environmental responsibility.

To the scientific experts, certifications can be viewed as the external manifestation of the evidence-based reasoning process. The requirements and models of such certification (e.g., the frameworks of the GMO regulation or sustainability by EFSA) turn the laboratory research into the trust of the society. Nevertheless, tension still exists between certification processes and scientists. Even though the certification systems can help to improve the quality of scientific claims, sometimes scientists themselves confess that the regulatory and bureaucratic layers sometimes get in the way of innovation or may suit political self-interests. Therefore, certification is in an ambivalent position to maintain public confidence and as a place, where the discussions of science, politics, and ideology take place.

Producers in the industry consider certification one of the necessary tools through which they can acquire legitimacy and competitiveness. News reports stated that while industry as a shareholders viewed the Commission’s oversight of ethanol production as “a missed opportunity” to highlight the sector’s positive contributions, the same oversight reassured consumers that regulatory control was in place. Companies view certification as a means of approval that enables them to promote their biofuel innovations on the basis of sustainability and compliance with international standards. This credential is now used as a strategic asset to avoid reputational issues commonly associated with GM technologies and as an indicator of environmental and ethical accountability for both investors and consumers.

In the industry, certification has been viewed by producers as one of the tools required by the producers in gaining legitimacy and competitiveness. According to the news reports, the industry as a shareholders perceived the Commission regarding the production of ethanol as a missed opportunity to bring into limelight what the sector was positively doing, but the oversight was a relief to the consumers that there is regulation in the production of ethanol. Companies consider certification as a model of endorsement that helps them to advertise their biofuels invention based on the principles of sustainability and meeting international standards. This certification has become an effective strategic resource to prevent reputational problems that are typically linked to GM technologies and signify environmental and ethical responsibility to investors and consumers.

Although the public has been offered reassurances using terms such as rigorous testing, biofuel biosafety approval, and sustainability certification, these cues help laypeople frame the unfamiliar concept of genetically engineered biofuels within a context of regulatory control. Nevertheless, this trust is weak and conditional. Once certification mechanisms become opaque or politicized, skepticism quickly returns. Notably, one African news source cited Project Solaris as an example showing that certification's legitimacy depends not only on its scientific foundation but also on perceptions of impartial and pluralistic oversight.

Thus, it can be seen that media portrayals of certification and standards demonstrate an advanced concept of trust in which governments assume responsibility, scientists transform risk into regulation, industries seek legitimacy, and NGOs challenge credibility. Innovation and public acceptance are therefore connected through certification. Although certification does not completely eliminate controversy, it nevertheless provides an institutionally grounded vocabulary through which society negotiates its conditional acceptance of GM biofuel, thereby bringing a degree of stability to the relationship between technology, regulation, and society. The key quotations from the news corpus are presented in *Appendix 27.*

4.5.2 International agreements

The trade and regulation of GM biofuel are not only about international agreements but also about public perceptions of the safety, legitimacy, and fairness of these activities. Media discourses highlight the WTO framework, USMCA, and the biosafety and trade policies of the European Union as significant arenas for negotiating national sovereignty and environmental protection. According to many members of the public, endorsement of or compliance with the rules of these institutions by GM biofuel producers is a mark of trust and fair governance. However, as soon as the agenda of trade liberalization appears to be prioritized over domestic precautionary policies or environmental protection, distrust within society begins to develop, as international agreements are then regarded as instruments of control rather than safeguards.

The discussion in European coverage is often structured around the themes of consumer protection and regulatory responsibility. An article from EurActiv stated that the European Commission's ethanol and protein strategy was a missed opportunity, as it overlooked the domestic production of GM-linked biofuel. Yet, the EU's very cautious stance in this matter also fortifies its position as a global promoter of ethical regulation and environmental safety. The emphasis of European institutions on ensuring that oversight takes priority before commercialization sends a clear message to the public that biosafety must not be used as a bargaining chip in economic development. This strong positioning helps build trust, signaling that GM biofuel policy in Europe is guided by concerns about health risks rather than economic gain.

In the corpus, various stakeholders strategically invoke international agreements to shape public perception. Governments and regulatory bodies emphasize compliance with global standards to project an image of responsibility. For instance, during the U.S.–

Mexico dispute over GM corn under USMCA, newspapers quoted officials stating that some member states had committed to basing their regulations on scientific research. Such framing reassures the general public that GM biofuel is governed by evidence-based regulatory frameworks rather than arbitrary or politically motivated rules. Meanwhile, industry representatives and trade associations argue for the need for harmonized standards to support innovation and competitiveness. The European Ethanol Association criticized the EU's divided regulatory environment and suggested that globally aligned standards would balance safety, progress, and economic interests.

On the other hand, civil society groups and associations are more critical, viewing these international treaties as double-edged instruments. Organizations such as Greenpeace and GM-Free Ireland invoke global trade-related debates about risks of contamination, loss of local control, competition versus commercialization, and the erosion of food sovereignty. Their warnings such as claims that even a few accidentally dispersed seeds could contaminate entire localities transform legal and policy issues into vivid narratives that resonate with the public, who, despite their trust in governance, may feel threatened by perceived risks to purity, safety, and equity. These stories appeal to broader audiences by framing the GM biofuel debate not only as a matter of technology or economics but also as one of community rights and ethical responsibility.

In conclusion, multiple international agreements continue to serve as both legitimacy markers and contested spaces within the GM biofuel debate. Governments and industries uphold these agreements to legitimize GM biofuels by labeling them as compliant with accepted norms and standards. NGOs and activists, in contrast, accuse the agreements of being opaque and unfair. In this context, the media acts as a mirror reassuring audiences about the existence of rules while simultaneously amplifying doubts about whose interests these rules serve. Therefore, public recognition of GM biofuel depends not so much on the agreements themselves as on perceptions of various actors regarding "who controls these agreements," "who benefits from them," and "to what extent they are seen as impeding protection versus enabling empowerment.” The key quotations from the news corpus are presented in *Appendix 28.*

4.5.3 Regulatory policies

Government regulation remains the main indicator for public perception on the acceptability of genetically modified (GM) biofuels. Media coverage always points out official actions like laws, bans, and authorizations to act as social signals both in favor of or against the GM biofuel being managed responsibly or if they are commercially driven. If regulations are depicted as transparent, science-orientated, and nation-oriented, then public opinion tends to be cautious acceptance. When policies appear to have been rushed, inconsistent, or political, however, skepticism and worry arise the public trust is very fragile and intensely dependent on procedural integrity being perceived.

Corn growers in America, interviewed by the Guardian team, lamented that a lot of criticism against subsidies has made them feel that their own country had turned against them. The reports stated that "farmers are growing the first corn plants genetically modified for the specific purpose of putting more ethanol in gas tanks rather than producing more food." Being an illustration of how government subsidies of new varieties of GM biofuel crops are exercised and creating a sense of dread among the people that energy concerns are of a priority over food security, media coverage underlined the tension as a regulatory problem and hence the narrow responsibility governments play in their decision toward innovation and social responsibility.

The role of regulation in safeguarding people was emphasized by the African and European news media. Greenpeace was quoted by African News as saying that, "use of genetically engineered maize for biofuels poses an unacceptable risk since the GM maize designed for industrial fuel contains proteins not normally present in the human diet." By giving priority to the NGO concerns, the press essentially translated very technical regulatory concerns into ethical and safety concerns, the concern being that government oversight should be the exercise of public responsibility. Likewise, one news article quoted EU chief scientific adviser Anne Glover, "If we are using land to produce biofuels, we are not producing food, and that means we have to intensify food production." For European media, regulation was seen as a binding moral contract binding citizens to science and in demonstrating that GM-linked biofuels can only be socially acceptable if governance is practiced with fairness and accountability and based on credible evidence.

The other problem is the approach to regulation that is set to influence the perception of the people in the Global South. Some news quoted, "There is an adage by an agricultural expert stating that the U.S., where GMO technology was born, has tried to confine GMO maize only to value chains such as biofuel and restrict supermarket-level entry." Contamination of the limited amounts curtails the criticality of the government policy as a shield and as a signal: biofuels are therefore guaranteed of being safe whilst unintentionally escaping into food systems. On the other hand, some depicted local views, "The importation of GM seeds and crops for the purpose of making biofuel would have constituted great danger to Irish agriculture: even if a handful of seeds had been accidentally scattered, they could have rapidly spread throughout the country and their contamination." The accentuation of public concern through regulatory weakness depicts how regulation and public perception interplay in the acceptance of GM biofuel.

Therefore, this news presentation underlines that the public response to GM biofuel is neither about the presence or absence of the technology but rather about the perceived authority bestowed on the governance of the technology. Tighter, transparent, and scientifically backed regulations have the media portray GM biofuel as responsible in helping the country towards sustainable energy. Trust is likely to dissolve when the regulators lack cohesion, when politics comes between them, and when implementation is not strict. Thus, regulation is the moral and institutional framework of legitimacy. If it cannot confer legitimacy to GM biofuel, they will be viewed by societies as somewhere between progressive innovation and potential harm. The key quotations from the news corpus are presented in *Appendix 29.*

4.6 Summary of Regulatory Policy

To sum up, media framing transforms the discussion regarding regulations and policies into ethical issues of trust, accountability, and legitimacy. Government agencies are portrayed as those in charge, while scientists are seen as the ones who bring reason to the debate, industries are portrayed as those seeking acceptance, and NGOs are depicted as the ones who consistently challenge authority. Certification, trade agreements, and regulatory frameworks, which are often considered merely part of administrative processes, become the signals through which the public determines whether GM biofuels are under safe governance or have been politically manipulated. Thus, media stories do not merely inform about policy changes; they also define the boundaries of public acceptance and influence how society negotiates the balance between technological advancement and social responsibility.

5. Discussion and Conclusion

This section discusses the research results in relation to existing knowledge. It focuses on the results of stakeholder identification and representation, the factors influencing public acceptance of GM biofuel, the tensions that have developed around GM biofuel, and policy perspective. It also highlights new insights that have emerged from the findings of this research. Moreover, this section outlines the limitations of this study and provides recommendations for future research and conclusions.

5.1 Discussion

To explain the GM biofuel controversy, this study connected stakeholder theory (Freeman and Reed, 1983; Mitchell et al., 1997; Gold, 2011) with discourse analysis to identify the relevant stakeholders and their influence in public acceptance. Previous studies have made substantial progress and provided stakeholder categories and presented their roles, such as introducing farmers and landowners as key adopters due to the presence of economic and environmental factors, and NGOs and academics as mediators that influence the public discussion through support and expert knowledge gathering (Mayfield et al., 2007; Leibensperger et al., 2021; Mai-Moulin et al., 2019). This study extended the previous studies by mapping stakeholder visibility, stakeholder frequency, and stakeholders' sentiment across regions and over time to show stakeholders' influence in public acceptance of GM biofuel. It is found that the frequently mentioned stakeholders in the corpus are producers, industry, scientific experts, consumers, and regulatory bodies. This study also found producers are presented as credible economic shareholders who are also anxious about unknown risks of GM crops, industries as promoters of GM biofuel highlighting economic growth and job opportunities, experts as assessors, consumers as cautious about transparency and food prices, and regulatory bodies or government are represented as policymakers and negotiators.

Besides, while the discussion is about tensions, earlier literature has mainly focused on food versus fuel (Lane, 2015; Pimentel et al., 2009). This study has identified and explained tensions between stakeholders on trade competitiveness vs. regulatory sovereignty, capital scaling vs. social justice, innovation vs. precaution along with food vs. fuel. This study has shown how these tensions materialize empirically in news media discourses by analyzing the context from news media considering the global perspective. The tensions have developed over time between stakeholders due to stakeholders' priorities, for example, land use, market control, food security, energy security, and policy regulation. The findings show that public acceptance of GM biofuel depends on transparency, trust, and inclusiveness.

Moreover, this study analyzed the stakeholders' position on biofuel policy. Past studies show that the policy frameworks are usually focused on market growth and energy security and do not focus on sustainability and social legitimacy (Sparks and Ortmann, 2011; Turcksin et al., 2011; Schillo et al., 2017). This study demonstrates that media representations of certification systems, regulatory authorities, and international treaties influence how legitimacy and fairness are publicly understood. Comparative studies also indicate that innovation- and risk-driven regulation are more prevalent in U.S. policies, while the EU is more concerned with ethical regulation and involvement of the community (Parrott et al., 2020; Wickson, 2014). This study agrees with this view that the policies of the EU and U.S. have considerable differences.

Furthermore, media play a crucial role in the public acceptance of GM biofuels. When coverage stresses risks such as food security and biosafety, it fuels doubt, when it highlights benefits such as energy security or economic benefit, it builds support (Mohr & Höhler, 2023; Scheufele, 1999). This result showed that news discourse contains both supportive frames—energy security, growth, and innovation—and critical frames—deforestation, biodiversity loss, and corporate control. Across regions, the acceptance also depends on the policy and market changes. Media therefore as a stakeholder play a key arena where science, politics, and public values meet to shape understanding, trust, and the broader social legitimacy of GM biofuels.

In summary, this study contributes several advancements to prior studies. First, it has integrated stakeholder voices, representation, and sentiment to explain acceptance dynamics. Then it has broadened the understanding of stakeholder tensions beyond traditional debates. Besides, the research gives a new angle to the issue by examining media coverage in different places, which turns out to be the factor for changing public attitudes in the case of different communication strategies and policy emphasis.

5.2 Limitation of the study

Despite this comprehensive approach, there are some limitations to this study. Firstly, the research considered only news articles available in English and within the LexisNexis database, which may exclude opinions from regions where news is not published in English or not accessible through LexisNexis. Secondly, the analysis relies solely on publicly available news; no stakeholder interviews were conducted to collect primary data. Thirdly, it is not always the case that how something is framed in the media directly reflects or changes public perception. Finally, although different tools were used for analysis, the process still involves human judgment, which means personal bias may influence the interpretation of meaning and the identification of frames.

5.3 Further Research

It is observed that GM biofuel is controversial; however, within the corpus, there are narratives that discuss non-GMO or GMO-free biofuels, which can be studied further. So far, the understanding is that non-GMO crop-based biofuels have no risk of contamination with food crops and no risk of biodiversity loss; however, the potential for large-scale production of such biofuels can be further examined. On the other hand, although GM crop-based biofuels carry risks of contamination and biodiversity loss, policies can be standardized for example, by examining whether zonal-based production could be a solution.

Additionally, it is observed that policies in Europe are stricter than those in the USA. The reasons for the EU's stringent policy can be studied further to identify the fundamental elements driving its cautious approach toward GM crops. It would help to understand whether the EU is overly cautious, or cautiousness is justified considering potential risks identified by the EU. At the same time, the approach of the USA can be examined in terms of its balance between risk and return as they are the promoter of GM biofuel.

5.4. Conclusion

The research reveals that GM biofuel remains controversial to the public primarily due to concerns over unknown risks to biodiversity, which may affect public health and food security. At the same time, positive aspects of technology are emphasized through narratives such as economic growth, energy security, cost efficiency, and sustainability. It is also observed that some people are not reluctant to use biofuel derived from non-GMO crops but are less willing to accept GMO-based biofuel.

Also, Consumers are increasingly demanding that GMO foods be labeled so they can be distinguished, and some governments have introduced zonal production policies to prevent GMO crops from mixing with non-GMO crops. These are among the public's key concerns, along with the potential unknown health risks. Since GMO crops are being promoted for large-scale biofuel production, it is important to strengthen public understanding of GM biofuel. External stakeholders can play a mediator role by facilitating dialogue between the public and relevant stakeholders to develop a better understanding.

In summary, this study concludes that public acceptance of GM biofuel depends largely on transparency, stakeholder accountability, and policy rather than technological innovation. To resolve the conflict between stakeholders, stakeholders like government and industries can come forward to discuss the conflict by ensuring ethical innovation experts can assess risks impartially, and the media can report responsibly which would lead the public trust and possibly acceptability of GM biofuel.

References

Ahmed, S., Warne, T., Smith, E., Goemann, H., Linse, G., Greenwood, M., Kedziora, J., Sapp, M., Kraner, D., Roemer, K., Haggerty, J. H., Jarchow, M., Swanson, D., Poulter, B., & Stoy, P. C. (2021). Systematic review on effects of bioenergy from edible versus inedible feedstocks on food security. Npj Science of Food, 5(1), 9. https://doi.org/10.1038/s41538-021-00091-6

Ambaye, T. G., Vaccari, M., Bonilla-Petriciolet, A., Prasad, S., Van Hullebusch, E. D., & Rtimi, S. (2021). Emerging technologies for biofuel production: A critical review on recent progress, challenges and perspectives. Journal of Environmental Management, 290, 112627. https://doi.org/10.1016/j.jenvman.2021.112627

Angelidaki I., & Ellegaard L. (2003). Codigestion of manure and organic wastes in centralized biogas plantsstatus and future trends. Applied Biochemistry Biotechnology 109(1–3), 95–106. https://link.springer.com/article/10.1385/ABAB:109:1-3:95

Atwell RC, Schulte LA, Westphal LM. Landscape, community, countryside: linking biophysical and social scales in US Corn Belt agricultural landscapes. Landsc Ecol 2009;24:791–806. https://doi.org/10.1007/s10980-009-9358-4.

Auer, T. O,. & Bene, F. D. (2014). CRISPR/Cas9 and TALEN-mediated knock-in approaches in zebrafish. Methods 69 (2), 142-150. https://doi.org/10.1016/j.ymeth.2014.03.027

Augustenborg CA, Finnan J, Mcbennett L, Connolly V, Priegnitz U, Müller C. Farmers' perspectives for the development of a bioenergy industry in Ireland. GCB Bioenergy 2012;4:597–610. https://doi.org/10.1111/j.1757-1707.2011.01151.x

Balogh, P., Bai, A., Popp, J., Huzsvai, L., & Jobbágy, P. (2015). Internet-orientated Hungarian car drivers' knowledge and attitudes towards biofuels. Renewable Sustainable Energy Reviews. 48, 17–26. https://doi.org/10.1016/j.rser.2015.03.045

Bauer, M. W. (2002). Controversial medical and agri-food biotechnology: a cultivation analysis. Public Understanding of Science, 11(2), 93-111. https://doi.org/10.1088/0963-6625/11/2/301

Bauer, M. W., Allum, N., & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. Public Understanding of Science, 16(1), 79–95. https://doi.org/10.1177/0963662506071287

Birch, K., Levidow, L., & Papaioannou, T. (2010). Sustainable Capital? The Neoliberalization of Nature and Knowledge in the European "Knowledge-based Bio-economy." Sustainability, 2(9), 2898–2918. https://doi.org/10.3390/su2092898

Boehm, J., Kayser, M., & Spiller, A. (2010). Two Sides of the Same Coin? Analysis of the Web-Based Social Media with Regard to the Image of the Agri-Food Sector in Germany. International Journal on Food System Dynamics, 01(3), 264–278. https://doi.org/10.22004/ag.econ.97029

Capalbo, D. M. F., Arantes, O. M. N., Maia, A. G., Borges, I. C., & Silveira, J. M. F. J. D. (2015). A Study of Stakeholder Views to Shape a Communication Strategy for GMO in Brazil. Frontiers in Bioengineering and Biotechnology, 3. https://doi.org/10.3389/fbioe.2015.00179

Chen, F., Zhao, Y., & Guo, P. (2024). *Recent advances of CRISPR-based genome editing for improvement of crop yield and quality. Frontiers in Plant Science, 15*, 1478398. https://doi.org/10.3389/fpls.2024.1478398

Chin H-C, Choong W-W, Wan Alwi SR and Mohammed AH. Issues of social acceptance on biofuel development. Journal of Cleaner Production 2014;71, 30–39. https://doi.org/10.1016/j.jclepro.2013.12.060

Chong, D., & Druckman., & J. N. (2007). A Theory of Framing and Opinion Formation in Competitive Elite Environments. Journal of Communication, 57(1), 99–118. https://doi.org/10.1111/j.1460-2466.2006.00331.x

Clapp, J. (2018). Mega-Mergers on the Menu: Corporate Concentration and the Politics of Sustainability in the Global Food System. Global Environmental Politics, 18(2), 12–33. https://doi.org/10.1162/glep_a_00454

Cohen, J. J., Reichl, J., & Schmidthaler, M. (2014). Re-focussing research efforts on the public acceptance of energy infrastructure: A critical review. Energy, 76, 4–9. https://doi.org/10.1016/j.energy.2013.12.056

Daugbjerg, C., & Feindt, P. H. (2017). Post-exceptionalism in public policy: Transforming food and agricultural policy. Journal of European Public Policy, 24(11), 1565–1584. https://doi.org/10.1080/13501763.2017.1334081

Delshad, A. B., Raymond, L., Sawicki, V., & Wegener, D. T. (2010). Public attitudes toward political and technological options for biofuels. Energy Policy, 38(7), 3414–3425. https://doi.org/10.1016/j.enpol.2010.02.015

Delshad, A., &Leigh R. (2013) Media Framing and Public Attitudes Toward Biofuels. Review of Policy Research 30(2), 190–210. https://doi.org/10.1111/ropr.12009

Dida, G., Nyoni, H., & Chidamba, L. (2024). *Biotechnology towards energy crops: A comprehensive review of biotechnological applications in the development of* *bioenergy crops. CAB Reviews, 19*(026), 1–11. https://cabiagbio.biomedcentral.com/articles/10.1186/s43170-024-00245-y

Du, L., & Rachul, C. (2012). Chinese newspaper coverage of genetically modified organisms. *BMC Public Health*, *12*(1), 326. https://doi.org/10.1186/1471-2458-12-326

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative Content Analysis: A Focus on Trustworthiness. Sage Open, 4(1). https://doi.org/10.1177/2158244014522633

Errera, M. R., Dias, T. A. da C., Maya, D. M. Y., & Lora, E.E.S. (2023). Global Bioenergy Potentials Projections for 2050. Biomass and Bioenergy 170, 106721. https://doi.org/10.1016/j.biombioe.2023.106721

Filip, O., Janda, K., Kristoufek, L., & Zilberman, D. (2019a). Food versus fuel: An updated and expanded evidence. Energy Economics, 82, 152–166. https://doi.org/10.1016/j.eneco.2017.10.033

Freeman, R. E., & Reed, DL (1983). Stockholders and stakeholders: A new perspective on corporate governance. California Management Review 25(3),88–106. https://doi.org/10.2307/41165018

Frewer, L. J., Van Der Lans, I. A., Fischer, A. R. H., Reinders, M. J., Menozzi, D., Zhang, X., Van Den Berg, I., & Zimmermann, K. L. (2013). Public perceptions of agri-food applications of genetic modification – A systematic review and meta-analysis. Trends in Food Science & Technology, 30(2), 142–152. https://doi.org/10.1016/j.tifs.2013.01.003

Gakpo, J. O., & Baffour - Awuah, D., (2024). The evolution of media reportage on GMOs in Ghana following approval of first GM crop. GM Crops & Food, 15(1), 200–211. https://doi.org/10.1080/21645698.2024.2365481

Galata Bickell, E. (2019). The framing effect of the media in the regulation of GMOs: a case study of Russia. Russian Journal of Communication, 11(3), 240–252. https://doi.org/10.1080/19409419.2019.1678348

Gamson, W. A., & Modigliani, A. Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach. American Journal of Sociology 95(1), 1–37. https://doi.org/10.1086/229213

Giraldo, L., Gracia, A., Do., & Amaral, E., 2010. Willingness to pay for biodiesel in Spain: a pilot study for diesel consumers. Spanish Journal of Agricultural Research. 8 (4), 887–894. https://doi.org/10.5424/sjar/2010084-1382

Gold, S (2011). Bio-Energy Supply Chains and Stakeholders. Mitigation and Adaptation Strategies for Global Change 16(4), 439–62. https://doi.org/10.1007/s11027-010-9272-8.

Gunningham, N., Kagan, R. A., & Thornton, D. (2004). Social License and Environmental Protection: Why Businesses Go Beyond Compliance. Law & Social Inquiry, 29(2), 307–341. https://doi.org/10.1111/j.1747-4469.2004.tb00338.x

Guo, M., Song, W., & Buhain, J. (2015). "Bioenergy and biofuels: History, status, and perspective," Renewable and Sustainable Energy Reviews, Elsevier, vol. 42(C), pages 712-725. https://doi.org/10.1016/j.rser.2014.10.013

Guosheng., X & Peng., L (2011). “Genetic Engineering of Energy Crops: A Strategy for Biofuel Production in ChinaFree Access.” Journal of Integrative Plant Biology 53(2), 143–150. https://doi.org/10.1111/j.1744-7909.2010.01022.x

He, Q., Xu, Y., Zhang, H., & Jiang, J. (2022). *Transformation and gene editing in the bioenergy grass Miscanthus. Biotechnology for Biofuels, 15*, 241. https://doi.org/10.1186/s13068-022-02241-8

Heaton, E. A., Flavell, R. B., Mascia, P. N., Thomas, S. R., Dohleman, F. G., & Long, S. P. (2008). Herbaceous energy crop development: Recent progress and future prospects. Current Opinion in Biotechnology, 19(3), 202–209. https://doi.org/10.1016/j.copbio.2008.05.001

Hill, J., Nelson, E., Tilman, D., Polasky, S., & D. Tiffany. (2006). Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels. Proceedings of the National Academy of Sciences, 103(30), 11206–11210. https://doi.org/10.1073/pnas.0604600103

Kalantari, F., Tahir, O. M., Akbari, R., & Azemah, N. (2018). The Importance of the public Acceptance Theory in determining the success of the vertical Farming projects. Management Research and practice. 10(1). https://www.researchgate.net/publication/323916918_THE_IMPORTANCE_OF_THE_PUBLIC_ACCEPTANCE_THEORY_IN_DETERMINING_THE_SUCCESS_OF_THE_VERTICAL_FARMING_PROJECTS

Kant, G., Hasan, A., Yadav, P., Pandey, A., and Srivastava, S. “The Generational Shift in Biofuels: A Path toward Sustainable Energy Solutions.” Biomass and Bioenergy. 196 (May 2025): 107757. https://doi.org/10.1016/j.biombioe.2025.107757

Kraeusel, J., & Möst, D. (2012). Carbon Capture and Storage on its way to large-scale deployment: Social acceptance willingness to pay in Germany. 49, 642-651) https://doi.org/10.1016/j.enpol.2012.07.006

Lane, J., 2015. EU reshapes its biofuels policy. Biodigest, [online]. Available at: http://www.biofuelsdigest.com/bdigest/2015/04/16/eureshapes-its-biofuels-policy/

Lecheler, S., & De Vreese, C. H. (2018). News Framing Effects. 1st edition., 198. https://doi.org/10.4324/9781315208077

Leibensperger, C., Yang, P., Zhao, Q., Wei, S., & Cai, X. (2021). The synergy between stakeholders for cellulosic biofuel development: Perspectives, opportunities, and barriers. Renewable and Sustainable Energy Reviews, 137, 110613. https://doi.org/10.1016/j.rser.2020.110613

Levidow, L., & Papaioannou, T. (2013). State imaginaries of the public good: Shaping UK innovation priorities for bioenergy. Environmental Science & Policy, 30, 36–49. https://doi.org/10.1016/j.envsci.2012.10.008

Lynas, M., Adams, J., & Conrow, J. (2022). Misinformation in the media: global coverage of GMOs 2019-2021. GM Crops & Food, 16(1), 18–27. https://doi.org/10.1080/21645698.2022.2140568

Mai-Moulin, T., Fritsche, U. R., & Junginger, M. (2019). Charting global position and vision of stakeholders towards sustainable bioenergy. Energy, Sustainability and Society, 9(1), 48 (2019). https://doi.org/10.1186/s13705-019-0225-0

Manetti, S. (2022). Genetically modified organisms - GMOs. MedlinePlus; National Library of Medicine. https://medlineplus.gov/ency/article/002432.htm

Marris, C. (2015). The Construction of Imaginaries of the Public as a Threat to Synthetic Biology. Science as Culture, 24(1), 83–98. https://doi.org/10.1080/09505431.2014.986320

Mayfield C. A., Foster C. D., Smith C. T., Gan J., & Fox, S. (2007). Opportunities, barriers, and strategies for forest bioenergy and bio-based product development in the Southern United States. Biomass and Bioenergy 31 (9), 631–637. https://doi.org/10.1016/j.biombioe.2007.06.021

McCormick, K. (2010). Communicating bioenergy: a growing challenge. Biofuels, Bioproducts and Biorefining. 4(5) 494-502. Https://doi.org/10.1002/bbb.243

Mitchell R. K., Agle B. R., & Wood D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of Management Review 22(4),853–886. https://doi.org/10.2307/259247

Mohr, S., & Höhler, J. (2023). Media coverage of digitalization in agriculture—An analysis of media content. Technological Forecasting and Social Change, 187, 122238. https://doi.org/10.1016/j.techfore.2022.122238

Moula, Md. M. E., Nyári, J., & Bartel, A. (2017). Public acceptance of biofuels in the transport sector in Finland. International Journal of Sustainable Built Environment, 6(2), 434–441. https://doi.org/10.1016/j.ijsbe.2017.07.008

Nelson, T. E., Clawson, R. A., & Oxley, Z. M. (1997). Media Framing of a Civil Liberties Conflict and Its Effect on Tolerance. American Political Science Review, 91(3), 567–583. doi:10.2307/2952075

Parrott, W. A., Harbell, J., Kaeppler, H., Jones, T., Tomes, D., Van Eck, J., Wang, K., & Wenck, A. (2020). The proposed APHIS regulation modernization could enhance agriculture biotechnology research and development in the USA. In Vitro Cellular & Developmental Biology - Plant, 56(1), 1–7. https://doi.org/10.1007/s11627-019-10039-x

Pimentel, D., Marklein, A., Toth, M. A., Karpoff, M. N., Paul, G. S., McCormack, R., Kyriazis, J., & Krueger, T. (2009). Food Versus Biofuels: Environmental and Economic Costs. Human Ecology, 37(1), 1–12. https://doi.org/10.1007/s10745-009-9215-8

Ponte, S. (2014). Roundtabling Sustainability: Lessons from the Biofuel Industry. Geoforum, 54, 261-271. https://doi.org/10.1016/j.geoforum.2013.07.008

Rossi A. M & Hinrichs, C. C. (2011). Hope and skepticism: farmer and local community views on the socio-economic benefits of agricultural bioenergy. Biomass and Bioenergy ,35(4), 1418–1428. https://doi.org/10.1016/j.biombioe.2010.08.036

Ruan, Yiqin, Jing Yang, and Jianbin Jin. "One Issue, Different Stories: The Construction of GMO Issues on Chinese, American and British Mainstream Media Portals." Cultures of Science 2, no. 4 (2019): 255–75. https://doi.org/10.1177/209660831900200403.

Sánchez, M.A., & Campos, H. (2021). Coexistence of Genetically Modified Seed Production and Organic Farming in Chile. GM Crops & Food, 12(1), 509–519. https://doi.org/10.1080/21645698.2021.2001242

Scheufele, D. A. (2008). Framing effects. In W. Donsbach (Ed.), The international encyclopedia of communication (pp. 1863–1868). Oxford: Blackwell.

Scheufele, D.A. (1999). Framing as a theory of media effects. Journal of Communication, 49(1), 103-122. https://doi.org/10.1111/j.1460-2466.1999.tb02784.x

Schillo, R. S., Isabelle, D. A., & Shakiba, A. (2017). Linking advanced biofuels policies with stakeholder interests: A method building on Quality Function Deployment. Energy Policy, 100, 126–137. https://doi.org/10.1016/j.enpol.2016.09.056

Schillo, R. Sandra, Diane A. Isabelle, and Abtin Shakiba. “Linking Advanced Biofuels Policies with Stakeholder Interests: A Method Building on Quality Function Deployment.” Energy Policy 100 (January 2017): 126–37. https://doi.org/10.1016/j.enpol.2016.09.056.

Schillo, R. Sandra, Diane A. Isabelle, and Abtin Shakiba. “Linking Advanced Biofuels Policies with Stakeholder Interests: A Method Building on Quality Function Deployment.” Energy Policy 100 (January 2017): 126–37. https://doi.org/10.1016/j.enpol.2016.09.056.

Shokravi, H. et al. (2021). Fourth generation biofuel from genetically modified algal biomass: Challenges and future directions. Chemosphere, 285, 131535. https://doi.org/10.1016/j.chemosphere.2021.131535

Siems, E., & Seuring, S. (2021). Stakeholder management in sustainable supply chains: A case study of the bioenergy industry. Business Strategy and the Environment, 30(7), 3105–3119. https://doi.org/10.1002/bse.2792

Smith HF, Sullivan CA. Ecosystem services within agricultural landscapes—farmers' perceptions. Ecol Econ 2014;98:72–80. https://doi.org/10.1016/j.ecolecon.2013.12.008

Sorda, G., Banse, M., Kemfert, C., 2010. An overview of biofuel policies across the world. Energy Policy 38(11), 6977–6988. https://doi.org/10.1016/j.enpol.2010.06.066

Sparks, G.D., Ortmann, G.F., 2011. Global biofuel policies: a review. Agrekon 50, 59–82. Steenblik, R., 2007.

Tapaninen, A. & Seppänen, M. (2008). Customers' Knowledge and Personal Attributes in Promoting De mand for Wood Pellet Heating Technologies. IEEE. https://doi.org/10.1109/IEEM.2008.4738008

Tomei, J., & Helliwell, R. (2016). Food versus fuel? Going beyond biofuels. Land Use Policy, 56, 320–326. https://doi.org/10.1016/j.landusepol.2015.11.015

Turcksin, L., Macharis, C., Lebeau, K., Boureima, F., Van Mierlo, J., Bram, S., De Ruyck, J., Mertens, L., Jossart, J.-M., Gorissen, L., Pelkmans, L., 2011. A multi-actor multicriteria framework to assess the stakeholder support for different biofuel options: the case of Belgium. Energy Policy 39, 200–214.

Tyner, Wallace E., 2013. Biofuels and food prices: separating wheat from chaff. Global Food Security. 2(2), 126–130. https://doi.org/10.1016/j.gfs.2013.05.001

Valentinov, Vladislav, and Robert Chia. “Stakeholder Theory: A Process-ontological Perspective.” Business Ethics, the Environment & Responsibility 31, no. 3 (2022): 762–76. https://doi.org/10.1111/beer.12441.

van Belle JF, Temmerman M, Schenkel Y (2003) Three level procurement of forest residues for power plant. Biomass Bioenergy 24(4):401–409. https://doi.org/10.1016/S0961-9534(02)00161-7

Van der Horst, D., 2007. Nimby or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy Policy 35 (5), 2705-2714. https://doi.org/10.1016/j.enpol.2006.12.012

Varela, V. J., Burgués, C., & Rösch, C. (2020). Acceptability of genetically engineered algae biofuels in Europe: Opinions of experts and stakeholders. Biotechnology for Biofuels, 13(1), 92. https://doi.org/10.1186/s13068-020-01730-y

Velazquez-Lucio, J., Rodríguez-Jasso, R. M., Colla, L. M., Sáenz-Galindo, A., Cervantes-Cisneros, D. E., Aguilar, C. N., Fernandes, B. D., & Ruiz, H. A. (2018). Microalgal biomass pretreatment for bioethanol production: A review. Biofuel Research Journal, 5(1), 780–791. https://doi.org/10.18331/BRJ2018.5.1.5

Vilella-Vila, Marta & Costa-Font, Joan, 2008. "Press media reporting effects on risk perceptions and attitudes towards genetically modified (GM) food," Journal of Behavioral and Experimental Economics (formerly The Journal of Socio-Economics), Elsevier, vol. 37(5), pages 2095-2106. https://doi.org/10.1016/j.socec.2008.04.006

Wan, S., Truong-Trire, V. M., Ward, T., Whalen, J. l, & Altosaar, I. (2017). Advances in the use of genetically modified plant biomass for biodiesel generation. Biofuels, Bioproducts and Biorefining, 11(4), 749–764. https://doi.org/10.1002/bbb.1777

Wickson, F. (2014). Environmental protection goals, policy & publics in the European regulation of GMOs. Ecological Economics, 108, 269–273. https://doi.org/10.1016/j.ecolecon.2014.09.025

Wolsink, M., 2007. Planning of renewables schemes. Deliberative and fair decision-making on landscape issues instead of reproachful accusa tions of non-cooperation. Energy Policy 35 (5), in press. https://doi.org/10.1016/j.enpol.2006.12.002

Wozniak, C. A., McClung, G., Gagliardi, J., Segal, M., & Matthews, K. (2012). Regulation of Genetically Engineered Microorganisms Under FIFRA, FFDCA and TSCA. In C. A., Regulation of Agricultural Biotechnology: The United States and Canada (pp. 57–94). Springer Netherlands. https://doi.org/10.1007/978-94-007-2156-2_4

Yuan, P., Zhang, Y., & Liu, H. (2024). *Advancements in plant gene-editing technology: From crop quality to bioeconomy. Biotechnology Journal.* https://doi.org/10.1002/biot.202400457

Youngs HL. The effects of stakeholder values on biofuel feedstock choices. In: Taylor C, Lomneth R, Wood-Black F, editors. Perspect. Biofuels potential benefits possible pitfalls, vol. 1116. Washington, DC: American Chemical Society; 2012. p. 29–67.

Appendix

Appendix 1: Distribution of Crops Across News Coverage

Quote	News Heading	Publisher	Pub. Date
Improved manufacturing processes: to enable more efficient biofuel production — in certain corn varieties, for example — by improving the process by which cellulose and/or starch is broken down and converted to fuel. This helps to reduce the environmental impact by decreasing the amount of water, electricity and natural gas needed to produce biofuel.	Understanding the purpose and process of GMO crops	Chicago Daily Herald	September 16, 2020
Oil-seed crops like canola, said Townley, cannot be turned straight into biodiesel - at least not in an efficient way. And canola, traditionally a Canadian crop, grows well in Western North Carolina when not much else will.	Field to fryer in Asheville	The Asheville Citizen-Times (North Carolina)	November 22, 2013
Further, it says that the use of genetically engineered maize for biofuels poses an unacceptable risk since the GM-maize designed for industrial fuel contains proteins that are not normally present in the human diet.	Africa; Are We Ready to Risk Smaller Brains, Livers And Testicles?	Africa News	May 26, 2008

Appendix 2: Sentiment in GMO and Biofuel Coverage

Quote	News Heading	Publisher	Pub. Date
Negative sentiment			
"On September 17, Honoka'a will play host to a movement aimed at taking back our island food source. The goal is to target Monsanto, a self-proclaimed "sustainable agriculture" company which aims to "protect" what some argue are intrinsic rights that deserve to be left alone."	Honoka'a to host "Occupy Monsanto" protest rally and concert on Sept. 17	Big Island Weekly	September 12, 2012
"Europe wanted to buy Australian canola, but would not accept GM product."	Monsanto props up weak GM crop price	The Australian	April 23, 2012
"The court ruled that the canola opponents had a 'very substantial likelihood of prevailing on the merits' in the case." regarding contamination of GM canola	No Canola to be Planted This Fall	Eugene Weekly	September 5, 2012
"Converting farmland to high-yield GMO production for the energy market could reduce the amount of land available for non-GMO products."	Clean fuels plan would drive GMO expansion in Oregon	The Oregonian (Portland Oregon)	March 8, 2015

The EU's proposed tariff on U.S. soybeans could affect trade in GMO soybeans, impacting the biofuel supply chain.	World: Soybean prices on exchanges and in Ukraine expect the introduction of duties on American soybeans by the EU and China	Food and Beverage: Ukraine and the worl	April 10, 2025
Positive sentiment			
Acknowledges the food-vs-fuel trade-off, suggesting GMO crops can help increase yields to offset land diverted to biofuels.	No risk with GMO food, says EU chief scientific advisor	EurActiv.com	July 24, 2012
"There is no substantiated case of any adverse impact on human health, animal health or environmental health, so that's pretty robust evidence."- Professor Anne Glover	Utopia Roman 30pt two deck heading	North Devon Journal	September 13, 2012
"The minister called upon Ugandan legislators to ensure the Biotechnology and Biosafety Bill is passed into law to enable farmers access crops that have been bred using modern biotechnology."	Advancing from genetic modification to synthetic biology in plant breeding	Daily Monitor	July 21, 2017
"The overall impact of less government regulation and more acceptance by the public of GMO products will reduce the cost of developing these products. The introduction of many new products is likely to follow, giving growers many more management options."	Biotechnology driving U.S. farm growth	Western Farm Press	December 15, 2007

Appendix 3: Key Stakeholders (Producers)

Quote	News Heading	Publisher	Pub. Date
"Europe needs a sustainable bioeconomy that makes the most efficient use of domestic agricultural production and makes an immediate impact in the fight against climate change." referring GMO free crops	ePURE members produce 5.6 billion litres of ethanol in 2019	Biofuels Internationa	September 1, 2020
"And specialty farmers in the Mid-Willamette Valley have been adamant they don't want canola in their backyards."	Low carbon fuel standard creates environmental woes	Statesman Journal (Salem, Oregon)	March 8, 2015

"The Flegels' long-term hope is the experiment will help offset their $75,000 annual fuel bill by turning the oil into biofuel."	Growing possibilities: A farming family with deep roots in Prineville hopes to be the first in the region to cultivate canola for oil	The Bulletin (Bend, Oregon)	June 15, 2009

Appendix 4 : Key Stakeholders (Industry)

Quote	News Heading	Publisher	Pub. Date
"Corn-based ethanol supports more than 40,000 jobs in Iowa, helping to catapult the Tall Corn State to first in the nation for biofuels production."	Q&A: CORN WATCH	Indian eGov Newswire	August 18, 2023
"South Korean refiner GS Caltex said Sunday it has teamed up with Posco International, the trading unit of steel giant Posco, to make a big push into the burgeoning biofuel market amid growing calls for emissions cuts globally."	GS Caltex, Posco International team up for biofuel push	THE KOREA HERALD	May 1, 2022
"I knew any business I did would use local resources for local needs… We're going to process those crops close to home and our market will be close to home." Full Sun Company anout Non-GMO crops	Coming soon to a grocery shelf near you: Vermont-grown kitchen oil	The Burlington Free Press (Vermont)	April 25, 2014 Friday

Appendix 5 : Key Stakeholders (Experts)

Quote	News Heading	Publisher	Pub. Date
"GMO technology has helped farmers not only achieve significant yield increases but has also reduced the use of chemical pesticides and weedicides. The technology is now exploited in new varieties of soya, corn, cotton and tomato." - Dr. Ahmad Ibrahim	Seeking new ways to overcome food crisis	New Straits Times (Malaysia)	June 18, 2008
"Scientists… have uncovered clues that may help them engineer plants more amenable to biofuel production."	National News	Grand Forks Herald (includes Agweek) (North Dakota)	April 27, 2009
"Some of the same groups that oppose GMOs want to reduce greenhouse gas emissions… You can't have it both ways."	No GMOs? Economic, environmental costs would be steep	Delta Farm Press	March 28, 2016

Appendix 6 : Key Stakeholders (Consumers)			
Quote	News Heading	Publisher	Pub. Date
“Most consumers have little confidence in the safety of GMO-processed food.”	Fears About GMOs	Korea Times	May 1, 2008
"Because we have no mandatory GMO labeling laws, as consumers we've had the choice taken away from us. We have no way of knowing what has GMO ingredients and what doesn't," said Green.	What are GMO foods and should you be told you're eating them?	FOX - 2 WJBK (Detroit)	March 13, 2013
Consumer and environmental activists are raising their voice against the imports, citing fears about safety of generically modified organisms (GMOs).	Fears About GMOs	Korea Times	May 1, 2008

Appendix 7 : Key Stakeholders (Regulator)			
Quote	News Heading	Publisher	Pub. Date
“However, Trump's planned budget cuts could limit subsidies for biodiesel producers.”	World: Soybean prices on exchanges and in Ukraine expect the introduction of duties on American soybeans by the EU and China	Food and Beverage: Ukraine and the worl	April 10, 2025
“On Saturday, the Government authorized the use of the GMO event Intact Soybean; in the next harvest. The production will be used exclusively for vegetable additive; for the manufacture of biofuels.”	Businessmen call authorization of biotechnology use 'an important step forward'.	CE Noticias Financieras English	October 20, 2024
“Renewable biofuel has a good ring to it. But before we heap praise on Ontario's government, we should take a closer look at the science behind the ethanol addition to gasoline.”	Reader letter: Questions raised about ethanol in fuel	Postmedia Breaking News	January 18, 2021

Appendix 8 : Key Stakeholders (Investors)			
Quote	News Heading	Publisher	Pub. Date
"Corporate investment validates biotech crops as a key pillar of next-generation biofuel production aligned with climate and carbon goals".	Missouri farmer talks experience with CoverCress	The Corn & Soybean Diges	July 13, 2022
"Even Sir Richard Branson is said to have invested in biofuel trains and planes".	Miracle crop or menace?	The Mercury (South Africa)	February 20, 2013

"We intend to bring the military, local and state governments and private industry together" to finance a full-scale production facility". Biofuel for the military	Papaya Power?	Big Island Weekly	January 10, 2012

Appendix 9 :Key Stakeholders (Non-governmental organization)

Quote	News Heading	Publisher	Pub. Date
The Bolivian Platform against Climate Change (Pbfcc), which brings together 51 environmental organizations, on Tuesday urged the population in Bolivia to mobilize "urgently" against carbon markets, use of GMOs and biofuels, when the country is discussing the implementation of these measures.	Environmentalists urge Bolivia to reject carbon and GMO markets	CE Noticias Financieras English	August 20, 2024
Organizations such as Friends of the Earth Europe claim that this technique can alter the genetic code of plants and animals faster and at more points in the DNA sequence than current methods.	The danger of the new transgenics	CE Noticias Financieras English	April 6, 2023
"Very productive smallholders would be replaced by large mechanised farms growing genetically modified maize to be used as biofuels in developed countries." Oakland Institute (Anuradha Mittal)	Tanzania; Agrisol's U.S. $100 Million Land Deal Opposed By U.S. Environment Group	Africa News	November 27, 2011

Appendix 10 :Key Stakeholders (Business federation)

Quote	News Heading	Publisher	Pub. Date
"The scheme will also trample on the mandate of the Agrarian Reform Program… which has been done before with multinationals trying to sell their GMO seeds."	UPSHOT; Chinese economic invasion	BusinessWorld	July 12, 2007
Pornsil Patchrintanakul, deputy secretary-general of the Thai Chamber of Commerce, called on the government to help growers increase their crop yields by turning to genetically modified organisms to serve demand from biofuel factories.	Exports to fall	The Nation (Thailand)	April 24, 2008
Obrador's corn ban is not just financially troubling for farmers, but also is a direct violation of an international treaty, according to Tadd Nicholson, executive director of Ohio Corn & Wheat Growers Association.	Ohio farmers concerned what Mexico's GMO corn ban means for the future	Mansfield News Journal Online (Ohio)	March 17, 2023

Appendix 11 :Key Stakeholders (Court/Legal system)			
Quote	News Heading	Publisher	Pub. Date
“The court ruled that the canola opponents had a ‘very substantial likelihood of prevailing on the merits’ in the case.” regarding contamination of GM canola	No Canola to be Planted This Fall	Eugene Weekly	September 5, 2012
“Kenya has already adopted the cultivation of GMO BT cotton and has completed clinical trials for BT maize and cassava which are awaiting the court determination of the cases filed before they are released to the market.”	Lifting the Ban on the Importation of GMO products will lower the cost of animal feeds by 30 per cent	Kenya News Agency	June 5, 2024
New breeding techniques continue to be a controversial issue. After the European Court of Justice ruled in 2018 that organisms obtained by NBTs should, in principle, fall under the GMO Directive, the Council of the EU has requested a study from the Commission to clarify the situation.	DG AGRI backs new breeding techniques for pest management	EurActiv.com	February 14, 2020

Appendix 12 :Key Stakeholders (Media)			
Quote	News Heading	Publisher	Pub. Date
“With the focus on clean energy, Algae.Tec technology to grow non-GMO algae on an industrial scale, and produce biofuels that replace predominantly imported fossil fuels can be the answer.”	Algae.Tec opens new facility in Australia	BioSpectrum Asia	August 16, 2012
“There is no doubt some GMO foods would have found their way into the diets of Nigerians, but two things that are of importance are; 1- did they (i.e. GMO food) get to the table through conventional cultivation done within Nigeria, or were they imported, and by escaping scrutiny, made it into meals without express consent of consumers?”	Nigeria: Stuck at crossroads of GMO for industrial growth, food security	Business Day	June 28, 2019
“What is drawing foreign corporates to African agriculture is the desire to push their patented GM seed, growing market for biofuels crops like maize and private profit, not public good.”	GMOs Will Not Make Zim Food Secure	The Herald (Harare)	July 28, 2014

Appendix 13 :Supportive Frame (Energy security & decarbonization)			
Quote	News Heading	Publisher	Pub. Date
"Algae.Tec offers the promise of home grown transport fuels (aviation and diesel), which is the number one energy security priority for countries like the USA and increasingly Australia,"	Algae.Tec opens new facility in Australia	BioSpectrum Asia	August 16, 2012

Locally produced biofuels can help Hawaii meet our carbon reduction goals with sustainable land use and farming.	Food, fuel, fiber	Honolulu Star - Bulletin (Hawaii)	March 29, 2009

Appendix 14 :Supportive Frame (Economic Growth)

Quote	News Heading	Publisher	Pub. Date
The Confederation of Private Businessmen of Bolivia (CEPB) qualified this Sunday as a "very important advance" the authorization of the use of biotechnology; with the event Genetically Modified Organism (GMO) Soya Intacta for the next harvest in Santa Cruz. (regarding biofuel production from GM crops)	Businessmen call authorization of biotechnology use 'an important step forward'.	CE Noticias Financieras English	October 20, 2024
Lifting the ban, the chair noted will allow local production of biofuel from low-cost GMO products which will be used to lower the cost of production and produce nutritious solubles that will increase feed quality. -Chairman, The Association of Kenya Feed Manufacturers (AKEFEMA)	Lifting the Ban on the Importation of GMO products will lower the cost of animal feeds by 30 per cent	Kenya News Agency	June 5, 2024
"The authorization of the GMO event Soya Intacta is a very important advance; to increase the production of biofuels; and a boost to the agroindustrial sector; which urgently needs the implementation of biotechnology"- President Luis Arce in the National Dialogue for the Economy and Production	Entrepreneurs highlight the authorization of the use of Intact Soybean as an important step for "the production of biofuels".	CE Noticias Financieras English	October 20, 2024 Sunday

Appendix 15 :Supportive Frame (Innovation and efficiency gains)

Quote	News Heading	Publisher	Pub. Date
European renewable ethanol association (ePURE) members produced 5.6 billion litres of ethanol and 5.33 million tonnes of co-products in 2019, according to new data.	ePURE members produce 5.6 billion litres of ethanol in 2019	Biofuels International	September 1, 2020
scientists are now applying new technologies which may not require laws for farmers to access the crops and these include use of application of synthetic biology involving gene editing and use of gene drives.	Advancing from genetic modification to synthetic biology in plant breeding	Daily Monitor	July 21, 2017

For the first time in Argentina, the sale of transgenic yeasts for the production of bioethanol from grain fermentation has been authorized .	It's the first transgenic: corn ethanol industry celebrates approval of a yeast	CE Noticias Financieras English	January 2, 2024

Appendix 16 :Supportive Frame (Co-products and circular bioeconomy)			
Quote	News Heading	Publisher	Pub. Date
Lifting the ban, the chair noted will allow local production of biofuel from low-cost GMO products which will be used to lower the cost of production and produce nutritious solubles that will increase feed quality.	Lifting the Ban on the Importation of GMO products will lower the cost of animal feeds by 30 per cent	Kenya News Agency	June 5, 2024
More than half of the corn crop is processed into renewable biofuels by turning the kernels' starch into fuel while the proteins remaining in the dried distillers grains become high quality livestock feed.	Q&A: CORN WATCH	Indian eGov Newswire	August 18, 2023
KSU feed mill receives $2 mlndonation- Ronald Kruse is donating $2 million for the construction of a feed mill with a biofuels co-product research facility at the new KSU Department of Grain Science and Industry campus in Manhattan, Kansas, USA.	Global Update	Feed Tech (English)	October 1, 2007

Appendix 17 :Supportive Frame (Trade access and competitiveness)			
Quote	News Heading	Publisher	Pub. Date
According to preliminary research and testing in neighboring countries, the Intacta event could allow, in the medium term, an increase of up to 30% in crop productivity. This increase will translate into greater surpluses for export, more foreign exchange for the country. (regarding Bolivia)	Soybean farmers consider approval of Intacta soybean a milestone, even though it will only be used to produce biofuels	CE Noticias Financieras English	October 21, 2024 Monday
Karuri said lifting the ban will allow local feed manufacturers to import highly nutritious, quality and high-yielding GMO products	Lifting the Ban on the Importation of GMO products will lower the cost of animal feeds by 30 per cent	Kenya News Agency	June 5, 2024

Appendix 18 :Critical Frame (Deforestation and land-use change)			
Quote	News Heading	Publisher	Pub. Date

Furthermore, by creating both fuel and feed, EU ethanol production offsets the need to import animal feed from countries where deforestation is actually happening.	Renewable ethanol is a win for EU's Farm to Fork strategy	Biofuels International	June 17, 2020
First-generation biofuels cause indirect-land-use change (iluc) and deforestation	Ireland increases crop-based biofuel transport share, provides 'business certainty'	EurActiv.com	April 30, 2018
Nevertheless, sustainability will still depend on whether farming can successfully continue to produce food over the long term with little or no damage to environment including deforestation, depleting groundwater, and inefficient use of nitrogen and phosphorus fertilisers.	Shifts in transitional protein solutions; Millennials are the drivers of change in many areas of food production - Part II	Fleischwirtschaft International	October 2, 2015

Appendix 19:Critical Frame (Biodiversity, contamination and gene flow)

Quote	News Heading	Publisher	Pub. Date
Jim Thomas, of the environmental thinktank ETC Group, says: "The risk is we have limited knowledge of how these things work. GM crops have out-crossed [bred with non-GM plants] after we were told they wouldn't. GM bacteria for transforming crops into biofuels have been shown to damage soil."	Guardian Weekly: Do-it-yourself genetics takes off	Guardian Weekly	April 10, 2009 Friday
The biofuel industry worldwide has, however, faced all kinds of criticism for its potentially adverse impacts on biodiversity	How sustainable is SAA's Project Solaris?	Bizcommunity.com (South Africa: Other industries)	February 25, 2015 Wednesday
Canola is grown as a food crop and for biofuels, but vegetable and specialty seed producers say the plant acts like a weed, cross-contaminates with vegetable seed crops like turnips and rutabagas, and conventional canola seed is often contaminated by genetically modified (GMO) canola.	No Canola to be Planted This Fall	Eugene Weekly	September 5, 2012

Appendix 20 :Critical Frame (Corporate power and seed dependence)

Quote	News Heading	Publisher	Pub. Date
"We reject the participation of Africa in carbon markets, GMO projects and biofuels farming"- Rural Women's Assembly	Climate; Women's Rural Assembly List of	Africa News	December 8, 2011

	Demands for African Govts		
There are other substantial unresolved challenges associated with GMOs, including the high economic concentration of the seed industry, facilitated by gene patents.	Feedback	Technology Review	March 1, 2014
"Fernandez addressed the employers enlisted in the Rural Society, the octopuses of the collection and production of oils, Cargill, Bunge, Dreyfus, Glencore, among others who continue to hoard about $6 billion without liquidating the Central Bank, despite the reduction of withholdings, at the rise in the price of biofuels"	The striking coincidences between Alberto and Mauritius in the IDEA Colloquium	CE Noticias Financieras English	October 21, 2020

Appendix 21:Critical Frame (Carbon markets and "false solutions")

Quote	News Heading	Publisher	Pub. Date
Rachel Smolker has researched, written and organized on the impacts of biofuels, bioenergy, and biochar on land use, forests, biodiversity, food, people, and the climate. She works with various coalitions, national and international, including the Mobilization for Climate Justice, Climate Justice Now, and others opposing marketbased solutions to climate change and other false solutions.	GENETICALLY ENGINEERED TREES: A "Cure" Worse Than the Disease	Daily Planet	May. 31, 2017
Añez is just sacrificing our food sovereignty for capitalist, transnational and business interests, which lead us to environmental disaster, continued impoverishment and health collapse.	In Bolivia agro-industrialstriales take advantage of militarized quarantine and impose criminal transgenic decree	NAFTA	May. 10, 2020
The FDA classifies GMOs as safe and says special labeling isn't necessary. The American Medical Association agrees, saying that labeling is misleading and will falsely alarm consumers.	What are GMO foods and should you be told you're eating them?	Newsbank, Inc.	March. 13, 2013

Appendix 22 :Critical Frame (Water use, pollution & eutrophication)

Quote	News Heading	Publisher	Pub. Date

The biofuel industry worldwide has, however, faced all kinds of criticism for its potentially adverse impacts on biodiversity, misuse of scarce land resources, and then there's the food vs fuel dilemma.	How sustainable is SAA's Project Solaris?	Bizcommunity.com	Feb. 25, 2025
On the flip side, there are various risks associated with biotechnology as well. One of the potential risks of biotech is the unintended use of genetically modified organisms leading to potential damage or disruption of natural ecosystems.	Promise and Perils of Biotechnology	Daily Times	March. 12,2025
It also warns that the implementation of biofuels through the cultivation of some introduced species "does nothing more than increase deforestation and alter climate cycles" in the country.	Environmentalists urge Bolivia to reject carbon and GMO markets	CE Noticias Financieras English	Aug. 20, 2024

Appendix 23 :Tensions form between stakeholder groups (Food vs Fuel)

Quote	News Heading	Publisher	Pub. Date
On a policy level, the government supports GMOs, Duffield told a session of the [2]National Biodiesel Board (NBB) annual conference devoted to the food-versus-fuel debate. Official support for GMOs as an answer to the feedstock supply challenge opens a new front in the battle for public acceptance of biofuels, which are already under fire over their perceived impact on food prices and alleged incitement of deforestation.	GMOs a factor in fuel vs food debate – USDA	Chemical News & Intelligence	Feb. 5, 2008
The biofuel industry worldwide has, however, faced all kinds of criticism for its potentially adverse impacts on biodiversity, misuse of scarce land resources, and then there's the food vs fuel dilemma.	How sustainable is SAA's Project Solaris?	Bizcommunity Publishing SA	Feb.25, 2015
The Government approved the use of biotechnology but only to increase soybean production for biofuel production. The rest of the production will be destined for the domestic market and for export.	The Government authorizes the importation of transgenic soybean seed.	CE Noticias Financieras English	Dec. 3, 2024

Appendix 24 :Tensions form between stakeholder groups (Innovation vs Precaution)

Quote	News Heading	Publisher	Pub. Date

"We are great admirers of the precautionary approach the European Union takes," said William Waren, a trade policy analyst at environmental group Friends of the Earth U.S. He said in Europe, the burden is on companies to show products are safe, as opposed to the U.S. where the onus is on the government environmental regulator to show products are unsafe.	US activists praise Europe"s ways in trade talks	The New Zealand Herald	July. 11, 2013
Nevertheless, furthering biotech research must be balanced with regulatory frameworks. In this regard, the Cartagena Protocol on Biosafety is a pivotal legally binding instrument that obligates its signatories to handle GMOs/LMOs securely and manage them in compliance with biosafety standards.	Promise and Perils of Biotechnology	Daily Times	March. 12,2025
The issue is dealt with in the document with a sentence demanding mandatory labelling for NGTs and rejecting patents on animals and plants. Another sentence, however, emphasises the opportunities of those technologies for higher yields. Both sentences are marked as under negotiation.	German coalition talks diverge on biotech, EU soil law and minimum wage	Euractiv Media Network	March. 26, 2025

Appendix 25 :Tensions form between stakeholder groups (Capital Scaling vs Social Justice			
Quote	News Heading	Publisher	Pub. Date
Añez is just sacrificing our food sovereignty for capitalist, transnational and business interests, which lead us to environmental disaster, continued impoverishment and health collapse.	In Bolivia agro-industrialstriales take advantage of militarized quarantine and impose criminal transgenic decree	NAFTA (English)	May.10, 2020
"With new biotechnological technologies, Bolivia will be able to compete on equal terms with Mercosur countries, such as Brazil, Argentina, Paraguay and Uruguay, where these events are already approved and in use," added Romero	Soybean farmers consider approval of Intacta soybean a milestone, even though it will only be used to produce biofuels	CE Noticias Financieras	Oct. 21, 2024

Appendix 26 :Tensions (Trade Competitiveness vs Regulatory Sovereignty)			
Quote	News Heading	Publisher	Pub. Date

Soybean prices on the Chicago and Ukrainian exchanges remain relatively stable as the world awaits a response to Trump's "tariff wars." China has refused to lift the 34% tariff imposed in response to U.S. tariffs, so Trump announced that he would impose an additional 50% tariff on Chinese goods starting April 9, making them subject to a 104% tariff. China has vowed to continue to fight the U.S. policy.	World: Soybean prices on exchanges and in Ukraine expect the introduction of duties on American soybeans by the EU and China	Food and Beverage	April. 10, 2025
"We are great admirers of the precautionary approach the European Union takes," said William Waren, a trade policy analyst at environmental group Friends of the Earth U.S. He said in Europe, the burden is on companies to show products are safe, as opposed to the U.S. where the onus is on the government environmental regulator to show products are unsafe.	The New Zealand Herald	US activists praise Europe"s ways in trade talks	July. 11, 2013
The EU is discussing loosening the GMO rules for certain plants developed with the latest generation biotechnologies.	German coalition talks diverge on biotech, EU soil law and minimum wage	Euractiv Media Network	March. 26, 2025

Appendix 27 :Stakeholder's Policy Perceptions (Certification and standards)

Quote	News Heading	Publisher	Pub. Date
Under the revised Renewable Energy Directive (RED II), the EU executive has proposed to reduce the contribution of conventional biofuels in transport from a maximum of 7% in 2021 to 3.8% in 2030. The first RED set a target of 10% of renewable energy sources in the transport sector, including first-generation biofuels made from food crops.	Ireland increases crop-based biofuel transport share, provides 'business certainty	EurActiv.com	April. 30, 2018
"Project Solaris has demonstrated that it can deliver sustainability on the ground in line with the RSBs global standard," said RSB's executive director, Rolf Hogan.	South Africa South African Biofuel Project Recognised for Sustainability	Africa News	Sep. 4, 2015
The authorization of the commercial use of the Saccharomyces cerevisiae yeast strains GICC03506 and GICC03486 by SENASA "marks a significant advance in the search for sustainable solutions for biofuel production in Argentina". Designed to improve bioethanol production efficiency, "these strains have passed rigorous scientific evaluations and have been endorsed by the Technical Advisory Committee on Genetically Modified Organisms".	EUROPE: Biofuel for aviation and shipping to be produced using GMO microbes	Machine-Building	April. 18, 2025

Appendix 28 :Stakeholder's Policy Perceptions (International agreements)			
Quote	News Heading	Publisher	Pub. Date
Furthermore, the EU actively promoted the conclusion of a new international agreement on climate change and signed, in April 2016, the Paris Agreement on climate change. In anticipation of that Agreement, the EU committed itself to reduce its greenhouse gas emissions by 2030 by 40 per cent, compared to 1990 levels, to ensure a share of renewable energies in the overall consumption of energy of 27 per cent and also to improve its energy efficiency by 27 per cent	Global environmental challenges and the EU	ERA Forum	Jan-19
THE GOVERNMENT'S anti-GMO (genetically modified organisms) policy is "misguided, unsustainable, and counterproductive", bio-technology company Monsanto has told the Oireachtas Agriculture Committee. The importation of GM seeds and crops for use in biofuel posed a significant risk to Irish agriculture, said Mr O'Callaghan as, even though these crops were not being grown in Ireland, the risk of contamination was high.	Biotechnology firm says State anti-GMO policy is 'misguided'	The Irish Times	July. 3, 2008
I'm glad the Biden administration is listening to my calls to step up efforts to resolve Mexico's free trade violations with U.S. corn exports. Mexico's ridiculous ban on GMO corn is not based on science and violates the USMCA free trade agreement. Iowa exports 16 million tons of corn to Mexico each year and I'm working to ensure this key market stays open.	Q&A: CORN WATCH	Indian eGov Newswire	Aug. 18, 2023

Appendix 29 :Stakeholder's Policy Perceptions (Regulatory policies)			
Quote	News Heading	Publisher	Pub. Date
"The Biofuels Obligation Scheme is a vital policy measure that increases the use of renewable energy and decreases emissions in the transport sector. Today I have published a Policy Statement setting out the increased level of obligation and future development of the scheme to 2030 and beyond," the minister said in a statement.	Ireland increases crop-based biofuel transport share, provides 'business certainty'	EurActiv.com	April. 30, 2018

Following the news that the Government, by means of a resolution, approved the incorporation of biotechnology for the Genetically Modified Organism event, they indicated that it is an important advance because it boosts the agro-industrial sector and contributes to the fulfillment of the agreements assumed with President Luis Arce in the "National Dialogue for the Economy and Production". CEPB stated that the authorization of the GMO event Soya Intacta will allow increasing the production of biofuels and will be a boost to the agroindustrial sector, "which urgently needs the implementation of biotechnology"	Entrepreneurs highlight the authorization of the use of Intact Soybean as an important step for "the production of biofuels".	CE Noticias Financieras	Oct. 20, 2024
Under the revised Renewable Energy Directive (RED II), the EU executive has proposed to reduce the contribution of conventional biofuels in transport from a maximum of 7% in 2021 to 3.8% in 2030. The first RED set a target of 10% of renewable energy sources in the transport sector, including first-generation biofuels made from food crops.	Ireland increases crop-based biofuel transport share, provides 'business certainty'	EurActiv.com	April. 30, 2018