GREENHOUSE GAS EMISSIONS FROM AGRIFOOD SYSTEM

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**Introduction**

In recent decades, concerns regarding climate change and its far-reaching implications have intensified global efforts to mitigate greenhouse gas emissions. Within this complex landscape, the agrifood system emerges as a pivotal player, wielding significant influence over environmental sustainability. This project seeks to delve into the intricate interplay between agrifood systems and greenhouse gas emissions, shedding light on the multifaceted factors contributing to carbon footprints within the food production and supply chain.

As the world's population burgeons and dietary preferences evolve, demands on agrifood systems have escalated, driving intensified agricultural practices and expanding food distribution networks. Yet, alongside these advancements lie nuanced environmental consequences, as agricultural activities account for a substantial portion of anthropogenic greenhouse gas emissions. Understanding the dynamics of emission sources within agrifood systems is thus paramount in formulating effective strategies for climate change mitigation and fostering sustainable food production practices.

Through comprehensive analysis and data-driven insights, this project aims to dissect the various components of agrifood systems contributing to greenhouse gas emissions. From agricultural practices such as livestock rearing and crop cultivation to transportation, processing, and distribution channels, each stage of the agrifood supply chain presents distinct opportunities and challenges in emission reduction efforts. By illuminating these intricacies, this project endeavors to inform policymakers, industry stakeholders, and consumers alike, fostering dialogue and catalyzing action towards a more sustainable agrifood future.

**Data**

The dataset utilized for this analysis of greenhouse gas emissions from the agrifood system originates from the *FAOSTAT* domain Emissions Totals, provided by the *Food and Agriculture Organization of the United Nations* (FAO). This dataset serves as a comprehensive repository of greenhouse gas emissions data generated within agrifood systems, meticulously calculated by the Tier 1 methodologies outlined by the *Intergovernmental Panel on Climate Change* (IPCC) Guidelines for National Greenhouse Gas (GHG) Inventories. Covering a vast array of emissions, including methane (*CH4*), nitrous oxide (*N2O*), carbon dioxide (*CO2*), and aggregate fluorinated gases (*F-gases*), the dataset encapsulates emissions across multiple facets of the agrifood system, ranging from farm gate activities to land use change and pre- and post-production food processes. Structured with adherence to stringent data standards, such as parameters like Country/Region, Country Group, Element, Item, Item Group, Year, Source, Flags, Glossary, and Units, the dataset ensures consistency and reliability in analysis.

Comprising over 15 thousand rows of meticulously curated data, the dataset offers an extensive temporal perspective, spanning from the year 2000 to 2021. This temporal breadth enables a comprehensive examination of emissions trends and patterns over time within the agrifood system. The emissions values are reported in units of kilotonnes (kt or 10^6 kg) of CO2 equivalent (CO2eq), utilizing the global warming potentials provided by the *IPCC Fifth Assessment Report (AR5)*. Methodologies for estimating emissions from various activities are extensively documented in dedicated working papers, incorporating data from reputable sources such as the *UN Statistical Division*, the *International Energy Agency (IEA)*, and the *PRIMAP-hist dataset v2.4.* Moreover, the dataset includes emissions reported by countries to the *United Nations Framework Convention on Climate Change* (*UNFCCC*), ensuring a robust and comprehensive representation of emissions across different geographical regions. However, it is essential to acknowledge potential data gaps, particularly for non-Annex I groups, owing to incomplete reporting mechanisms.

**Analysis**

In conducting the analysis of greenhouse gas emissions within agrifood systems, a meticulous data cleaning process was undertaken to ensure the integrity and reliability of the dataset. Utilizing Microsoft Power BI, an initial phase involved a comprehensive review of the dataset's structure and attributes to identify any anomalies, such as missing values or inconsistencies. Through careful examination, missing data points were meticulously addressed, and redundant or irrelevant columns were filtered out, streamlining the dataset to focus solely on variables relevant to the project's objectives. This rigorous cleaning process laid the foundation for subsequent analysis, providing a robust and reliable dataset for further exploration.

Following the data cleaning phase, advanced data transformation techniques within Power BI were employed to refine the dataset further. Tasks included standardizing units, converting data types, and judiciously removing outliers to optimize the dataset for rigorous analysis. Throughout this iterative process, paramount emphasis was placed on upholding principles of data integrity and accuracy, ensuring the dataset's suitability for insightful exploration of greenhouse gas emissions within agrifood systems. By meticulously preparing the data in this manner, potential biases and inaccuracies were minimized, enabling more accurate and reliable analysis results. This meticulous approach to data cleaning and transformation ensured that the subsequent analysis would be based on a solid foundation, enhancing the credibility and robustness of the findings.

**Results and Discussion**

1. *Oceania remains consistently at the bottom with minimal fluctuations in emission value*

The consistent position of Oceania at the bottom with minimal fluctuations in emission values underscores the region's commitment to environmental sustainability and climate action. Several factors contribute to this observed trend. Firstly, Oceania's relatively low levels of industrialization compared to larger continents result in fewer emissions from industrial activities. Additionally, the region's reliance on renewable energy sources, such as hydroelectric, solar, and wind power, further mitigates greenhouse gas emissions. Policies promoting renewable energy adoption and climate change mitigation strategies, coupled with international agreements like the Paris Agreement, provide a regulatory framework for reducing emissions and transitioning towards a low-carbon economy. Furthermore, sustainable agriculture practices in Oceania, encouraged by policies promoting soil conservation, agroforestry, and organic farming, contribute to minimizing emissions from land use change and agricultural activities. Specific policies, such as Australia's Renewable Energy Target and New Zealand's Emissions Trading Scheme, exemplify the region's commitment to reducing emissions and transitioning to renewable energy sources. While challenges such as increasing urbanization and population growth may arise, Oceania's proactive approach to environmental conservation and climate action positions the region as a leader in sustainable development. Moving forward, continued investment in renewable energy infrastructure, implementation of stringent emissions regulations, and adaptation to changing environmental conditions will be essential for Oceania to maintain its trend of stable emission values and contribute to global efforts to combat climate change.

1. *Manure left on Pasteur is a significant driver of heightened greenhouse gas emission*

The finding that manure left on pasture serves as a significant driver of heightened greenhouse gas emissions underscores the critical need for improved manure management practices in agrifood systems. Inadequate management of manure, characterized by on-pasture deposition without proper collection and storage, leads to the release of methane and nitrous oxide, potent greenhouse gases. Despite being a widely practiced and historically considered sustainable technique, the continued use of this method contributes significantly to emissions. Factors such as agricultural intensification and environmental conditions further exacerbate emissions from manure. Addressing this issue requires the implementation of enhanced manure management strategies, including composting, anaerobic digestion, and controlled application to fields, to mitigate emissions while also promoting soil fertility. Collaborative efforts among policymakers, farmers, and stakeholders are essential to develop and implement effective measures to reduce greenhouse gas emissions from manure in agrifood systems, thereby contributing to climate change mitigation and environmental sustainability.

1. *Fires in organic soil accounted for 55% of total fire emissions in 2006*

Fires in organic soil, historically prevalent in peatlands and marshes, have long been recognized as significant contributors to greenhouse gas emissions and environmental degradation. These fires, often ignited by natural factors such as lightning strikes or human activities like land clearing, can smolder underground for extended periods, releasing stored carbon into the atmosphere in the form of carbon dioxide (CO2) and other greenhouse gases. The year 2006 marked a notable period in which fires in organic soil accounted for a substantial portion, 55%, of total fire emissions, indicating a critical juncture in understanding the impact of these events. This finding underscores the urgent need for proactive measures to address the challenges posed by fires in organic soil. Prevention efforts, including regulating land use practices and raising awareness about the risks associated with peat fires, are essential to mitigate future occurrences. Additionally, effective management strategies such as prescribed burning and ecosystem restoration are crucial for minimizing the environmental impact of these fires and protecting vulnerable ecosystems. Collaborative efforts among stakeholders, including governments, conservation organizations, and local communities, are paramount to effectively addressing the complex issues surrounding fires in organic soil, ultimately contributing to environmental sustainability and climate change mitigation.

1. *Fires in organic soil led to a 48% higher CO2 emission compared to other fires average emissions.*

The observation that fires in organic soil led to a 48% higher CO2 emission compared to other fires' average emissions highlights the significant environmental impact of these specific types of fires. This finding underscores the disproportionate contribution of fires in organic soil to greenhouse gas emissions, emphasizing the urgent need for targeted interventions to mitigate their environmental effects. The higher CO2 emissions from these fires suggest the need for enhanced prevention and management strategies to address the challenges posed by fires in organic soil.

1. *Food Household consumption emits the maximum greenhouse gases in the agriculture supply chain*

While agricultural production processes contribute significantly to greenhouse gas emissions, it is the consumption stage where the greatest emissions occur. This result underscores the importance of addressing consumer choices and behaviors to mitigate the environmental footprint of the agrifood system. Strategies such as promoting plant-based diets, reducing food waste, and supporting sustainable food production practices can help minimize greenhouse gas emissions associated with food household consumption. Educating consumers about the environmental impact of their food choices and empowering them to make more sustainable decisions is essential for achieving meaningful reductions in emissions throughout the agriculture supply chain. Collaborative efforts among policymakers, food producers, retailers, and consumers are necessary to create a more sustainable food system that minimizes greenhouse gas emissions and promotes environmental stewardship.

**Conclusion**

This project has provided a comprehensive analysis of greenhouse gas emissions within agrifood systems, shedding light on the intricate dynamics shaping carbon footprints throughout the food production and supply chain. As concerns regarding climate change continue to mount, understanding the sources and drivers of emissions within agrifood systems is essential for devising effective strategies to mitigate environmental impacts and promote sustainability. The results of our analysis highlight the multifaceted nature of greenhouse gas emissions in the agri-food sector, spanning from agricultural practices to consumption patterns, and underscore the need for holistic approaches to address these challenges.

One of the key findings of this project is the varying contributions of different regions and activities to greenhouse gas emissions within agrifood systems. Regions such as Oceania exhibit distinct emission patterns, reflecting a combination of factors including industrialization levels, energy sources, and agricultural practices. Policies promoting renewable energy adoption, sustainable agriculture, and emissions reduction play a crucial role in shaping emission trends in these regions. Similarly, activities such as manure management and fires in organic soil emerge as significant drivers of emissions, highlighting the importance of targeted interventions to address these sources.

Moreover, the analysis underscores the critical role of consumer behavior in driving emissions within the agrifood system. Food household consumption emerges as a major contributor to greenhouse gas emissions, emphasizing the need for consumer-focused strategies to promote sustainable food choices and reduce environmental impacts. Initiatives such as promoting plant-based diets, reducing food waste, and supporting sustainable food production practices can play a pivotal role in mitigating emissions at the consumption stage.

Overall, this project serves as a call to action for policymakers, industry stakeholders, and consumers alike to collaborate in fostering a more sustainable agrifood future. By implementing proactive measures to reduce emissions, promote sustainability, and address environmental challenges, we can pave the way towards a more resilient and environmentally responsible agrifood system. Through continued research, policy innovation, and collective action, we can work towards a future where agrifood systems contribute to, rather than detract from, global efforts to combat climate change and promote environmental sustainability.

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**Appendix**

**Setup**

1. Pre-steps include setting up a Microsoft PowerBI desktop

**Data Ingestion, Cleaning, and Data Visualization**

1. Downloaded dataset from FAOSTAT
2. Data cleaning through Power Query Editor and data visualization in PowerBI

<https://app.powerbi.com/links/B4KVV6jAO9?ctid=2dea8c9d-71a9-4880-9787-6c261cf49665&pbi_source=linkShare>