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ANALYSIS OF THE POTENTIAL IMPLEMENTATION OF A METHANE-BASED CARBON TAX IN THE LIVESTOCK SECTOR IN INDONESIA

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Abstract
As one of the contributors to greenhouse gas emissions, methane emissions produced by the livestock sector are something that must be addressed immediately. A carbon tax could be one option that can be implemented to overcome this problem. This research aims to discuss whether there is potential to implement a methane-based carbon tax in the livestock sector in Indonesia. This research uses a qualitative approach with a systematic literature review and uses the PRISMA method. The literature used is publications published from 2020 to 2024. Research shows that there is potential for implementing a methane-based carbon tax and there is potential for implementing a carbon tax in the livestock sector. It is hoped that this research will provide clarity regarding the potential for implementing a carbon tax in Indonesia and become a reference for other studies in the future. The limitation of this research is that there has not been a comparison of ideal practices in implementing methane-based carbon taxes in other countries with existing regulations in Indonesia.
Keywords: Carbon tax, GHG, Livestock, Methane tax

INTRODUCTION

Greenhouse Gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4), from nitrous oxide (N_2O), increasing globally due to anthropogenic activities (Shakoor dkk., 2021). These gases have a key role in influencing changes in the Earth's climate by absorbing and re-releasing energy from the lower layers of the atmosphere (Montzka dkk., 2011). Although methane and nitrous oxide are emitted in lower amounts compared to carbon dioxide, the potential of methane and nitrous oxide to increase global warming is 21 times and 310 times greater (Thangarajan dkk., 2013).Therefore, although methane and nitrous oxide emissions are lower, their impact on global warming is very significant and requires more serious attention and mitigation measures.

The livestock sector is one of the contributors to greenhouse gas emissions produced by humans, namely around 14% of total greenhouse gas emissions, the majority of which comes from methane (Grossi dkk., 2019). Methane in the livestock sector is mainly produced through the digestive processes of ruminant animals and from manure management (Grossi dkk., 2019). Driven by population growth, increasing income, and urbanization, demand for livestock products will increase due to increasingly high food needs (Cheng et.al., 2022). Hal This has the potential to increase methane emissions, requiring more in-depth monitoring in its management.

Indonesia is one of the largest methane emitting countries in the world. In fact, based on data *from International Energy Agency (2022)* Indonesia is ranked 6th in the world's largest producer of methane gas, with an emission level of 14.3 million tonnes per year. Some of these emissions come from the livestock sector. Indonesia, together with 9 other methane producing countries, contributes 57% of total methane emissions global anthropogenic. With this position, Indonesia has a big responsibility to reduce emissions and contribute to global climate change mitigation efforts.

Many countries have implemented carbon tax policies as a regulatory tool to reduce greenhouse gas emissions. A methane-based carbon tax could be an effective instrument to encourage livestock farmers to adopt more environmentally friendly and sustainable practices. One of the countries that implemented the first carbon tax in the world was Sweden in 1991

(Andersson, 2019). The carbon tax was introduced at a rate of US$30 per tonne of CO_2 then increased gradually to reach US$127, which is currently one of the highest carbon taxes in the world (World Bank, 2024). Singapore was the first country to implement a carbon tax in Southeast Asia on January 1 2019. The carbon tax rate in Singapore is set at S$5/$tCO_{2e}$ as a transition period to adapt, which then increased to S$25/$tCO_{2e}$ to support the net zero emissions (National Climate Change Secretariat, t.t.). As part of the international community, Indonesia has a commitment to reduce greenhouse gas emissions in accordance with international agreements, *Paris Agreement*, by 29% by 2030 with its own efforts and reducing emissions by up to 41% with international support (Reyseliani et.al., 2022). This shows Indonesia's seriousness in dealing with climate change and contributing to global efforts to reduce greenhouse gas emissions. It is hoped that the implementation of a carbon tax in the livestock sector will help Indonesia's efforts to support sustainable livestock practices.

Even though a lot of research is starting to raise the topic of carbon taxes, there is still not much discussion regarding the implementation of a methane-based carbon tax in Indonesia. In fact, the implementation of a methane-based carbon tax in the livestock sector has not been implemented in the world. Previous research on methane taxes was conducted by oleh Nafi'ah & Dinarjito (2024) which discussed the potential for taxes on methane in food waste.

Denmark will be the first country in the world to introduce a carbon tax on emissions in the livestock sector (McDonnell, 2024). The opportunity for implementing a carbon tax in the livestock sector to reduce emissions and the limitations of research discussing the potential for implementing a carbon tax in the livestock sector attracted the attention of the author to conduct a literature review with a qualitative approach using a systematic literature review (*Systematic Literature Review*/SLR) and using the PRISMA method to find out whether there is potential for implementing methane-based taxes, whether there is potential for implementing taxes in the livestock sector, and whether there is potential for implementing methane-based taxes in the livestock sector in Indonesia. It is hoped that this research will provide clarity regarding the potential for implementing a carbon tax in Indonesia and become a practical contribution to other studies in the future to support Indonesia's net zero emissions target by 2060. The preparation of this research begins with an introduction, literature review, methods, followed by discussion, conclusions, suggestions, and research limitations.

LITERATURE REVIEW

Greenhouse gas is a type of gas that can absorb infrared radiation or heat emitted by the earth. These gases function to trap this heat in the atmosphere, thereby preventing it from returning to outer space. Over time, these processes contribute to global warming and climate change (Amoo & Layi Fagbenle, 2020). Based on the UN Convention on Climate Change, greenhouse gases consist of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6). It should be noted that greenhouse gases do not have an entirely negative impact. In fact, several greenhouse gases are always present in our environment and help regulate the earth's temperature by preventing the occurrence of very low temperatures, which would not support food production and the survival of marine and terrestrial ecosystems (Amoo & Layi Fagbenle, 2020). However, the current high levels of greenhouse gases in the environment have been attributed to human influence.

As one of the second largest sources of greenhouse gas contributors after carbon dioxide, methane is produced in large quantities as a byproduct of the natural gas extraction process (Amoo & Layi Fagbenle, 2020). Although it is second only to carbon dioxide as a greenhouse gas, its impact over a hundred-year period is estimated to be 34 times greater than that of CO_2 (United Nations Climate Change, 2014).

The livestock sector's contribution to greenhouse gas emissions reaches 15%, of which around 37% comes from methane (CH_4) (Adegbeye dkk., 2019). For example, the carbon footprint of livestock farming in China increased by 71% between 2005 and 2015 (Li dkk., 2021). Carbon emissions produced by livestock mostly come from feces and urine produced by livestock and poultry, as well as carbon dioxide emissions and intestinal gas produced when animals breathe. Apart from that, carbon emissions also result from waste and pollutants that appear during the livestock process, as well as from other direct emission sources (Crutzen dkk., 1986). However, it is important to remember that in the process of raising animals, indirect carbon emissions and environmental pollution caused by resource use also have a significant impact. Research shows that cattle, sheep and pigs are the main contributors to greenhouse gas emissions in the livestock sector (Shi dkk., 2022).

Therefore, on *Conference of Parties* 26 *United Nations Framework Convention on Climate Change* (UNFCCC COP26), a global commitment has been agreed to address the problem related to methane, known as *Global Methane Pledge* (GMP). A total of 111 countries, which account for 45% of human emissions, have joined this commitment. GMP member countries pledge to reduce their national methane gas emissions by at least 30% of methane emissions levels by 2020, with a target completion date of 2030. The duration of this commitment is relatively short, but significant reductions in methane emissions could have a rapid cooling impact for the earth. With this step, it is hoped that the world can achieve stabilization of average temperatures below 1.5 degrees Celsius, while still reducing CO emissions.$_2$ sustainably (International Energy Agency, 2022).

Indonesia needs to implement comprehensive policies to reduce methane emissions, considering its role as one of the largest methane producers in the world. One step that can be implemented is to impose a carbon tax. A carbon tax is one way to overcome environmental problems caused by greenhouse gas emissions and is a form of Pigouvian tax (Carattini dkk., 2018). Pigouvian taxes are imposed on market activities that aim to internalize costs generated by negative externalities, such as economic costs caused by pollution (Kallbekken dkk., 2011).

The Indonesian government has launched the implementation of a carbon tax in Indonesia, through Law (UU) Number 7 of 2021 concerning Harmonization of Tax Regulations. The law includes provisions for a carbon tax as an effort to reduce greenhouse gas emissions in Indonesia. The implementation of the carbon tax should have begun to be applied on a limited basis to sectors operating in the field of coal-fired power plants starting April 1, 2022. However, the implementation of the carbon tax has been postponed until 2025 because the government requires more careful consideration regarding the impact on industrial development in Indonesia (Mutrofi'ah, 2023). Baranzini et.al., (2017) stated that a carbon tax is an important tool to internalize the costs of greenhouse gas emissions so that it can encourage companies and consumers to change their behavior and switch to more environmentally friendly economic activities.

METHODS

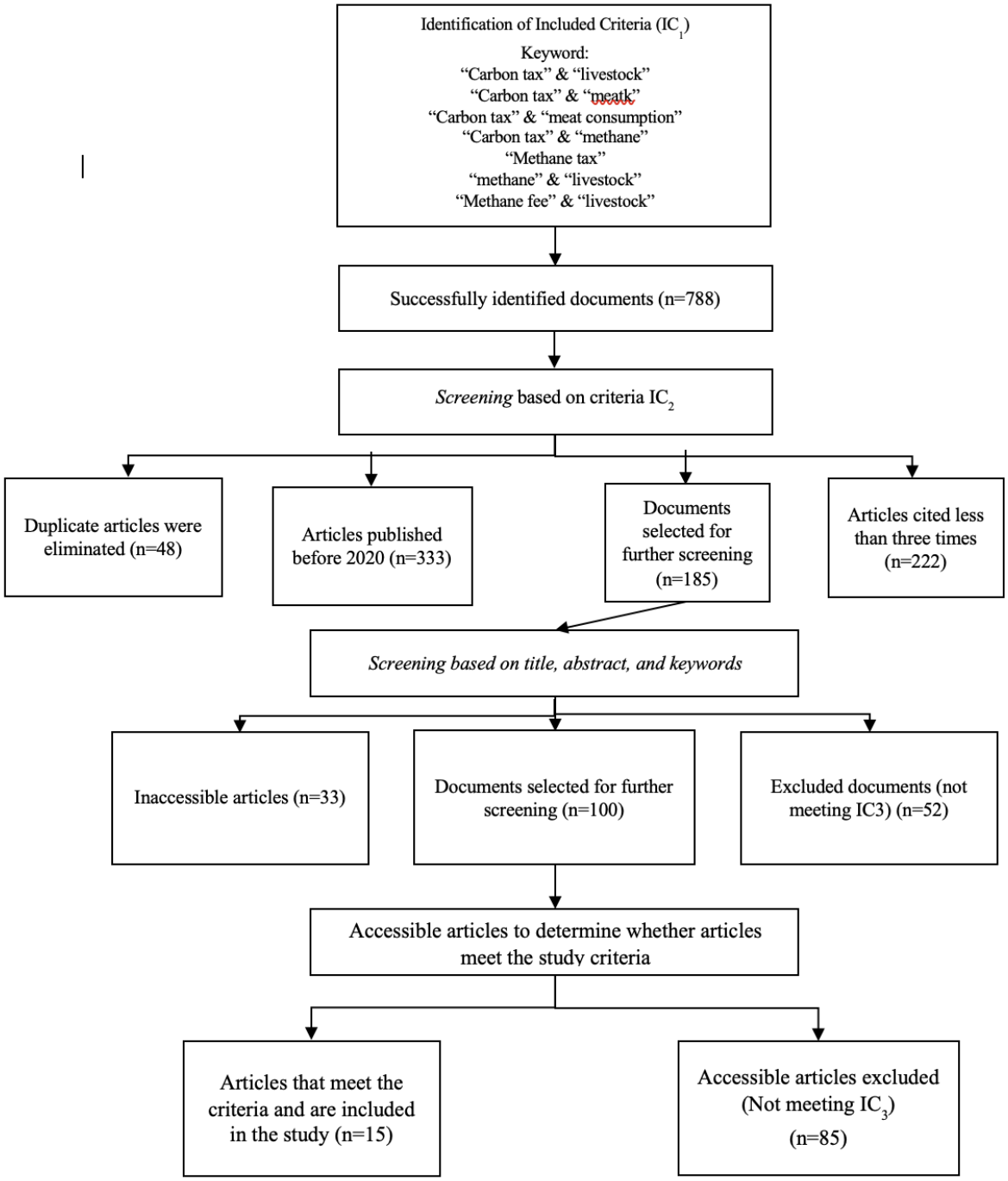
This research uses descriptive methods to explain the potential for implementing methane-based taxes in the livestock sector in Indonesia. The approach used is a qualitative approach to deepen understanding of the potential for implementing a methane-based carbon tax in the livestock sector through an exploration and review process. Systematic literature review method (*Systematic Literature Review*/SLR) by using the technique *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA) is used to collect and analyze information from journals and articles related to the research theme.

This research involves five stages, namely determining eligibility criteria, identifying sources of information, selecting literature, collecting data, and sorting data. First, determining

the literature eligibility criteria is carried out by establishing inclusion criteria (*Inclusion Criteria*/IC). This study included three inclusion criteria: (1) IC_1: the article is original research that has gone through a review process and is written in Indonesian or English; (2) $I.C_2$: article published at least in 2020 and has been cited at least three times since publication; and (3) IC_3: the article aims to identify the potential for implementing a methane-based carbon tax in the livestock sector. Second, a literature search was conducted through online databases that have large collections of academic studies, including searching reference lists for articles that met the inclusion criteria.

Third, the literature selection stage is divided into four sub-stages, namely determining keywords, searching and selecting titles, abstracts and keywords, reading articles in full or parts that have not been eliminated, and compiling a list of references from selected articles for further review. and identification of related studies. Fourth, the data collection process is carried out manually by compiling a data extraction form which includes information regarding the author's name, title, year of publication, name of the publisher's journal or conference, country, type and methodology of research, as well as related research findings. Finally, in selecting data items, there are two types of data that will be obtained, namely article demographics and research conclusions. Article demographics include the distribution of studies related to the implementation of methane-based carbon taxes in the livestock sector, the countries where the research was conducted, as well as the distribution of research types and methodologies used. Meanwhile, the research conclusions relate to the potential for implementing a methane-based carbon tax in the livestock sector in Indonesia.

Figure 1. PRISMA *Framework*



Source: Processed by the author

Based on the final selection shown in Figure 1, the author succeeded in identifying 15 articles in English that discussed the potential for implementing a methane-based carbon tax as well as the potential for implementing a tax in the livestock sector by eliminating articles that were considered less relevant to this research. In analyzing the selected articles, the author identified the research methodology used, research results that were relevant to the research questions, as well as the main limitations of the research in producing conclusions. Next, all research results are summarized to answer the research questions. After going through these stages, a comprehensive understanding of the research results can be obtained based on the articles that have been reviewed. Table 1 presents a list of articles selected for review.

Table 1. List of Articles Selected for Review

No.	Researcher, Year	Article Title	Journal Name	*Ranking* Journal	Country
1	M Olczak, A Piebalgs, P Balcombe (2022)	*Methane regulation in the EU: Stakeholder perspectives on MRV and emissions reductions*	*Environmental Science & Policy*	Q1	Dutch
2	A Horrillo, P Gaspar, C Díaz-Caro, M Escribano (2021)	*A scenario-based analysis of the effect of carbon pricing on organic livestock farm performance: A case study of Spanish dehesas and rangelands*	*Science of The Total Environment*	Q1	Dutch
3	A Yamamoto, TKU Huynh, Y Saito, & TF Matsuishi (2022)	*Assessing the costs of GHG emissions of multi-product agricultural systems in Vietnam*	*Scientific Reports*	Q1	English
4	J Trewern, J Chenoweth, & I Christie (2022)	*"Does it change the nature of food and capitalism?" Exploring expert perspectives on public policies for a transition to 'less and better' meat and dairy*	*Environmental Science & Policy*	Q1	Dutch
5	AM Alvim, & ER Sanguinet (2021)	*Climate Change Policies and the Carbon Tax Effect on Meat and Dairy Industries in Brazil*	*Sustainability*	Q1	Swiss
6	J Roosen, M Staudigel, & S Rahbauer (2022)	*Demand elasticities for fresh meat and welfare effects of meat taxes in Germany*	*Food Policy*	Q1	English

No.	Researcher, Year	Article Title	Journal Name	*Ranking* Journal	Country
7	In Huang (2022)	*Demand for plant-based milk and effects of a carbon tax on fresh milk consumption in Sweden*	*Economic Analysis and Policy*	Q1	Dutch
8	X Gao, & Y Zhang (2023)	*Feasibility Study of China's Carbon Tax System under the Carbon Neutrality Target—Based on the CGE Model.*	*Sustainability*	Q1	Swiss
9	K Mittenzwei (2020)	*Greenhouse Gas Emissions in Norwegian Agriculture: The Regional and Structural Dimension*	*Sustainability*	Q1	Swiss
10	K Nakano & K Yamagishi (2021)	*Impact of Carbon Tax Increase on Product Prices in Japan*	*Energies*	Q1	Swiss
11	D Stepanyan, C Heidecke, B Osterburg, & A Gocht (2023)	*Impacts of national vs European carbon pricing on agriculture*	*Environmental Research Letters*	Q1	English
12	G Forero-Cantor, J Ribal, & N Sanjuan (2020)	*Levying carbon footprint taxes on animal-sourced foods. A case study in Spain*	*Journal of Cleaner Production*	Q1	English
13	S Kumari, RK Fagodiya, M Hiloidhari, RP Dahiya, & A Kumar (2020)	*Methane production and estimation from livestock husbandry: A mechanistic understanding and emerging mitigation options*	*Science of The Total Environment*	Q1	Dutch
14	F Funke, L Mattauch, I van den Bijgaart, HCJ Godfray, C	*Toward Optimal Meat Pricing: Is It Time to Tax Meat Consumption?*	*Review of Environmental Economics and Policy*	Q1	American

No.	Researcher, Year	Article Title	Journal Name	*Ranking* Journal	Country
	Hepburn, D Klenert, M Springmann, & N Treich (2022)				
15	T Jansson, N Malmström, H Johansson, & H Choi (2024)	*Carbon taxes and agriculture: the benefit of a multilateral agreement*	*Climate Policy*	Q1	English

RESULTS AND DISCUSSION

A total of 15 articles were selected through a screening process as described in the methodology section. Table 1 presents a list of selected article titles, researcher name and year of publication, journal name and country of publication, as well as the ranking of the journal.

To answer the research question, an analysis was carried out on each article which included the research method, main results/findings, and whether the research found any potential for implementing a methane-based carbon tax and/or the potential for implementing a carbon tax in the livestock sector, as well as the main limitations of the article. reviewed. This information is summarized in Table 2. Follow-up discussions were conducted to answer the research questions thoroughly.

Table 2. Articles that analyze the potential for implementing a methane-based carbon tax and/or the potential for implementing a carbon tax in the livestock sector

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
1	M Olczak, A Piebalgs, P Balcombe (2022)	Qualitative method through interviews with 59 professionals to evaluate the effectiveness of MRV implementation (*Measurement, Reporting, and Verification*) in managing methane emissions in the oil and gas sector.	The main barriers to MRV implementation are a lack of understanding of measurement, the most effective methane quantification technologies, and how to fine-tune emission consistency. Although measurement technology has developed rapidly, it is still not possible to measure all emissions continuously with high accuracy and precision.	No, currently a methane tax cannot be implemented in the European Union due to the requirement of a unanimous decision in the European Union Commission.	-	The research only focuses on the implementation of the MRV system for methane emissions in the oil and gas sector in the European Union which is dominated by companies in the middle and downstream sectors and the research sample is not fully representative because it includes stakeholders who are active in the European Union decision-making process, so it does not represent global conditions. .
2	A Horrillo, P Gaspar, C	Quantitative method using numerical	The research results show that the application of the	Of	It is not explicitly stated that a carbon	The research object was only limited to

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
	Díaz-Caro, M Escribano (2021)	data analysis to calculate greenhouse gas emissions and carbon absorption using *Life Cycle Assessment* (LCA).	economic value of carbon (*carbon pricing*) can provide positive economic incentives for animal husbandry, especially in the context of sustainability. Applying the economic value of carbon to livestock that functions as a carbon sink can encourage conversion to more sustainable organic practices. Carbon sequestration can produce a negative emissions balance within a 20-year period, which shows the potential application of the economic value of carbon in contributing to climate change mitigation.		tax can be applied to the livestock sector because the focus of the research is the application of the economic value of carbon. However, there are indications that implementing a carbon tax in the livestock sector could be carried out taking into account various factors, such as type of agriculture and carbon sequestration to avoid negative impacts on economic and environmental outcomes.	six organic farms in Spain so that different conclusions could be drawn if the research was carried out in other countries with different farming conditions.
3	A Yamamoto, TKU Huynh, Y Saito, & TF	Quantitative methods use data from *Vietnam*	Research shows that livestock breeders in the Mekong Delta region have lower technical	Yes. However, the policy of implementing a	A carbon tax could be applied to the livestock sector to	The research object is only limited to Vietnam so different

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
	Matsuishi (2022)	*Household Living Standard Survey* (VHLSS) by using *Morishima Elasticity of Substitution* (MES) and GHG shadow price analysis and using test analysis *Wilcoxon rank-sum*.	efficiency compared to livestock breeders in other regions of Vietnam. This shows that policy interventions such as carbon taxes can be more effective in reducing gas emissions in this region.	methane-based tax needs to take into account the diversity of livestock breeders in Vietnam and not just imitate policies implemented in developed countries.	encourage farmers to switch to sustainable and environmentally friendly methods, such as better feed management and the use of technology that reduces emissions. However, a carbon tax could have a significant negative impact on GDP per capita which could hamper Vietnam's economic growth. Therefore, the government needs to consider using tax revenues to compensate the farmers involved.	conclusions can be drawn if the research is carried out in other countries with different farming conditions. The GHG emissions estimates in this research are based on the emissions intensity of the production system so that more detailed emissions data will be useful in formulating more specific policies.
4	J Trewern, J Chenoweth, & I Christie (2022)	The qualitative method uses semi-structured interviews with	Taxing unsustainable livestock systems could help internalize the resulting environmental costs. On the	Of	A carbon tax can be applied to the livestock sector and has a high potential	Interviews were conducted with only 16 experts who may not be representative

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
		experts who have significant expertise in food or agricultural policy. The analysis method used is multi-stage thematic analysis with a deductive and inductive coding approach, which was carried out using NVivo software.	other hand, providing subsidies to more sustainable livestock systems can encourage farmers to adopt environmentally friendly practices. By designing taxes and subsidies that are targeted and aligned with clear outcomes, these policies can create incentives for livestock farmers to reduce environmental impacts, as well as contribute to ecosystem restoration and increased carbon sequestration.		impact. However, there is a big possibility that this policy will face challenges or resistance from various parties, including from breeders and the community. The implementation of this policy could also cause job losses in the livestock sector, especially for small farmers and families.	enough to answer the questions in the research. Semi-structured interviews may produce data that is influenced by the subjective biases of respondents, which may influence the interpretation and analysis of results.
5	AM Alvim, & ER Sanguinet (2021)	Quantitative methods use models *Computable General Equilibrium* (CGE) to analyze the effects of implementing a carbon-based tax on	The imposition of a carbon tax affects production costs, which forces companies to adjust *output* them to minimize costs thereby affecting domestic and international trade. The imposition of a carbon tax causes a substitution effect	Of	A carbon tax can be implemented in the livestock sector but the implementation of environmental sustainability policies must be carried out without harming strategic	The research only considers the application of a carbon tax to emissions produced by the final product of production activities, so it does not describe the effect of a carbon

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
		production, trade and greenhouse gas (GHG) emissions in the Brazilian economy.	which makes production shift from sectors with high emissions (such as beef and milk) to sectors with lower emissions (such as pork and chicken) which results in a reduction in greenhouse gas emissions.		industries, such as the beef industry. Implementing taxes on the livestock sector at lower rates can minimize the negative impact on decreasing production and increasing exports.	tax on emissions produced in the production process.
6	J Roosen, M Staudigel, & S Rahbauer (2022)	Quantitative method with the AIDS Model (*Almost Ideal Demand System*) which is used to estimate meat demand based on price and expenditure elasticities for meat by socio-economic group.	High carbon tax (US-$100 per kg CO_{2e}) resulted in greater greenhouse gas emissions reductions, with an average reduction of 5 kg CO_{2e} per month per household. Tax *excise* Carbon is proven to be more efficient than taxes *to value* because the costs incurred to reduce emissions are lower in all household groups. This indicates that taxes *excise* carbon can be more effective in achieving emission reduction targets and	Of	A carbon tax can be implemented in the livestock sector but research more focused on consumption meat, not on raising livestock so that a carbon tax is imposed on consumers.	Research is limited to analyzing the demand impact of meat taxes, without considering the supply side, such as the reaction of producers and livestock farmers to changes in demand due to the tax.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
			minimizing negative impacts on community welfare.			
7	In Huang (2022)	The quantitative method uses the EASI demand system model (*Exact Affine Stone Indeks*) to analyze the relationship between price, expenditure, and household demographic characteristics in the context of milk consumption.	Implementing a carbon tax on fresh animal milk can reduce the annual carbon footprint which ranges from 4,890 kg to 14,316 kg. A carbon tax imposed on low-fat milk is expected to provide the greatest reduction in the carbon footprint of raw milk consumption, followed by a tax on standard milk. However, implementing a carbon tax on plant-based milk could actually increase the associated carbon footprint due to the substitution effect between plant-based milk and low-fat milk as well as standard milk. In general, the results suggest that imposing a carbon tax on fresh milk from animals, rather than on plant-based milk, is more likely to encourage	Of	A carbon tax can be implemented in the livestock sector but research more focused on consumption milk, not on raising livestock so that the carbon tax is imposed on consumers.	There was weak separability between food subcategories. This suggests that the effect of a carbon tax on raw milk consumption may influence the consumption of other food products, which could result in higher greenhouse gas emissions if other products are not taxed.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
			environmentally friendly consumption of fresh milk.			
8	X Gao, & Y Zhang (2023)	Quantitative methods use models *Computable General Equilibrium* (CGE) to analyze the impact of carbon tax policies on carbon emissions and economic development.	The implementation of a carbon tax has proven effective in reducing carbon emissions. The higher the carbon tax rate, the greater the emissions reduction achieved. A carbon tax policy implemented over a longer period of time will be more effective and can help achieve the target of carbon neutrality by 2060. Although a carbon tax can reduce emissions, in the short term, its implementation can have a negative impact on economic growth, including a decrease in GDP and consumer income . However, in the long term, a carbon tax could encourage industrial restructuring and increase population incomes.	Yes. Carbon tax policies and carbon trading systems are policy instruments to achieve lower carbon emissions. However, implementing a carbon tax is more suitable for developing countries, while a carbon trading system is more suitable for developed countries.	-	The research object is only limited to China so different conclusions can be drawn if the research is carried out in other countries with different farming conditions.
9	K Mittenzwei (2020)	Quantitative methods using dynamic simulation	Implementation of a carbon tax at a rate of €60 per ton of CO_{2e} resulting in significant	Of	A carbon tax can be applied to the livestock sector.	Lack of explicit modeling of animals as input in the

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
		models to analyze the impact of various policy options on greenhouse gas (GHG) emissions, the regional distribution of agricultural activities and the agricultural structure of the Norwegian agricultural sector.	reductions in GHG emissions. In the scenario that implements a carbon tax, GHG emissions are reduced to a greater extent compared to the scenario without a carbon tax.		However, additional mitigation options or increased carbon tax rates are needed to achieve more significant emissions reductions.	production function. This becomes very relevant in the context of GHG emissions accounting, because animals contribute a large proportion of GHG emissions from the agricultural sector.
10	K Nakano & K Yamagishi (2021)	Quantitative methods use life cycle-based analysis (*Life Cycle Assessment* - LCA) which is process-based. This research also analyzes five scenarios with different amounts and methods of taxation to evaluate the impact of	Price increases caused by a carbon tax could encourage consumers to change their consumption patterns, for example, by switching from products that have a high carbon footprint (such as beef) to lower-emission options (such as vegetables or chicken).	Yes. Implementation of a more comprehensive carbon tax, including taxes on gases other than CO_2, can help achieve higher emissions reduction targets.	A carbon tax could be applied to the livestock sector to reduce methane emissions from animal digestion and waste processing.	This research uses several scenarios to analyze the impact of a carbon tax, but these scenarios may not cover all possible situations that could occur in the implementation of a carbon tax.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
		increasing carbon taxes on product prices.				
11	D Stepanyan, C Heidecke, B Osterburg, & A Gocht (2023)	Quantitative methods use the CAPRI model (*Common Agricultural Policy Regional Impact*) to evaluate the impact of different policy scenarios on greenhouse gas emissions and the agricultural sector.	Implementation of a carbon tax of 100€/tCO_2eq in Germany without considering mitigation technologies (CPDE scenario) reduces emissions in the EU by about 5 MtCO_2eq (−1.28%).	Yes. However, mitigation technologies can also reduce methane emissions such as anaerobic digestion at the farm level, low nitrogen feed, flaxseed as a feed additive, nitrate as a feed additive, and vaccination against methanogenic bacteria in the rumen.	A carbon tax can be applied to the livestock sector accompanied by mitigation technology that can reduce emissions in the livestock sector. A carbon tax could also help reduce emissions leakage, where production moves to other countries with looser regulations. By implementing a carbon tax on the livestock sector, countries can maintain the competitiveness of domestic producers while still meeting	The research only focuses on agricultural emissions and does not consider emissions or removals from the Land Use, Land Use Change and Forestry (LULUCF) sector. This omission may limit the comprehensiveness of the analysis, as the LULUCF sector can significantly influence the overall greenhouse gas balance.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
					emissions reduction targets.	
12	G Forero-Cantor, J Ribal, & N Sanjuan (2020)	Quantitative methods use *Almost Ideal Demand System* (AIDS) to calculate price and expenditure elasticities and methods *Moving Block Bootstrap* to estimate the empirical distribution of the total carbon footprint associated with the consumption of animal source foods.	The research results show that a carbon tax applied to certain food products can potentially reduce GHG emissions. Taxes imposed on fish were found to be most effective in reducing the total carbon footprint, while taxes on pork showed less effectiveness. Taxes on products with a high carbon footprint do not always result in the greatest reductions in emissions, suggesting that consumer responses to taxes may vary depending on preferences and substitution between products. Research finds that there are substitution and complementarity relationships between various food products. For example, when a tax is imposed on beef, consumers are likely to switch to pork or chicken,	Yes. Research also suggests that there needs to be a combination of taxes on various products to achieve more effective emissions reductions.	A carbon tax could serve as an economic incentive to encourage a shift in consumption patterns from higher-emission meat products to more environmentally friendly alternatives, such as fish or poultry. By reducing demand for red meat which has a high carbon footprint, this tax could contribute to reducing emissions from the livestock sector. A carbon tax applied directly to the livestock sector, along with taxes on certain animal	Although the AIDS model effectively captures consumer preferences and tastes, it may not account for some habits or cultural factors that influence how consumers respond to taxes. These unmeasured habits can have a significant impact on consumer behavior and the effectiveness of tax policy.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
			which can increase emissions from those products. The tax on beef also suggests that despite reductions in emissions from beef, total emissions from consumption of animal source foods may not be reduced as significantly as consumption of other meats increases.		products, could create a greater impact in reducing overall emissions.	
13	S Kumari, RK Fagodiya, M Hiloidhari, RP Dahiya, & A Kumar (2020)	The quantification method uses approximation *top-down* And *bottom-up*. Approach *top-down* using atmospheric measurement data and inverse models, while the approach *bottom-up* based on emissions inventory and activity data from international published sources. Statistical	A carbon tax could provide an economic incentive for livestock farmers to adopt more environmentally friendly management practices, such as changes in livestock diets, breeding management, and better livestock management. By implementing a carbon tax, livestock farmers will be more motivated to reduce methane emissions to avoid additional costs arising from the tax. This can encourage innovation and adoption of technology that is more	Yes. The research also highlights that carbon taxes will be more effective if implemented in conjunction with other mitigation strategies, such as diet management and livestock management.	A carbon tax can be applied to the livestock sector and will be more effective if implemented in conjunction with other policies and strategies, such as education programs for livestock farmers and economic incentives for sustainable practices. The successful	Data regarding methane emissions from the livestock sector can vary greatly depending on various factors, including livestock type, diet, and environmental conditions. This variability can affect the accuracy of emissions estimates and the effectiveness of proposed mitigation strategies. There are limitations

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
		(empirical) models estimate emissions based on animal and feed characteristics, while simulation (mechanistic dynamic) models simulate methane production using a mathematical formulation of the biochemistry of rumen fermentation.	efficient in managing emissions. Although carbon taxes have the potential to reduce emissions, there are challenges in implementing them, such as determining appropriate rates and monitoring to ensure compliance.		implementation of a carbon tax in the livestock sector also depends on strong policy support from the government.	in the method of measuring methane emissions, both in terms of approach *top-down* nor *bottom-up*. For example, approach *top-down* that use satellite data may not be accurate enough to identify specific emission sources, while approaches *bottom-up* inventory-based ones can require extensive data and are often difficult to obtain.
14	F Funke, L Mattauch, I van den Bijgaart, HCJ Godfray, C Hepburn, D Klenert, M Springmann,	Quantitative method estimates the external costs of meat consumption, including greenhouse gas emissions and health costs, and provides an estimate	A meat consumption tax is considered a viable tool to reduce the adverse effects of meat consumption on the environment. This shows that a meat consumption tax can lead to a reduction in meat consumption, thereby reducing greenhouse gas	Of	Research places greater emphasis on meat consumption taxes, which are considered advantageous because they are relatively easy to implement	The research only considers the application of a carbon tax to emissions produced by the final product of production activities so it does not describe the effect of a carbon

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
	& N Treich (2022)	of what percentage increase in meat prices is needed to cover these external costs (20-60%).	emissions. Implementing a simpler tax system would likely be easier to implement and understand but would be inefficient in achieving environmental goals. Implementing a more complex tax system will be more effective but may face challenges in implementation and acceptance by society.		compared to other regulatory measures. This tax is borne by consumers and does not limit production in the livestock sector. A carbon tax should also be considered in the context of other existing policies, such as livestock subsidies and stricter livestock standards. These policies can complement each other to achieve greater emissions reductions and increase the sustainability of food systems.	tax on emissions produced in the production process.
15	T Jansson, N Malmström, H	Quantitative methods by simulating five	The implementation of a unilateral carbon tax in the European Union led to	Of	Taxes can be applied to the livestock sector	The research object is only limited to the European Union so

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
	Johansson, & H Choi (2024)	policy scenarios using the CAPRI model are used to analyze interactions between the agricultural sector, international trade and greenhouse gas emissions.	significant carbon leakage, with 76% of the reduction in emissions within the European Union being offset by increased emissions outside the European Union. This suggests that unilateral policies may reduce emissions in certain regions but may lead to increased emissions in other countries that do not implement similar taxes. global emission reduction in the EUTAX scenario only reaches 0.074%. However, when this tax is combined with a carbon adjustment mechanism at the border (*Borders Crossing Agreement*), the leakage rate was reduced to 36%, and the global emissions reduction increased to 0.15%. Taxes calculated based on GDP per capita have low efficiency, with a reduction in global		because the livestock sector is one of the main contributors to greenhouse gas emissions. However, if a tax is only implemented in one country or region, there is a risk that production could move to other countries where the tax is not implemented, which could reduce the effectiveness of the policy in reducing emissions globally. It must also be ensured that the carbon tax does not burden small farmers or animal husbandry in developing countries, so a	different conclusions can be drawn if the research is carried out in other countries with different farming conditions.

No	Researcher, Year	Research methods	Results and Discussion	Is there potential for implementing a methane-based carbon tax?	Is there potential to implement a carbon tax on the livestock sector?	Research Limitations
			emissions of only 270 Mt CO_2-eq (4,2%).		mechanism is needed to support small livestock farmers and animal husbandry in developing countries.	

Is there potential to implement a methane-based carbon tax?

Based on the results of the article review that has been carried out, there are two opinions regarding the potential for implementing a methane-based carbon tax. According Horrillo et. al., (2021), Yamamoto dkk. (2022), Trewern et. al., (2022), Alvim & Sanguinet (2021), Roosen dkk. (2022), Huang (2022), Gao & Zhang (2023), Mittenzwei (2020), Nakano & Yamagishi (2021), Stepanyan et. al., (2023), Forero-Cantor dkk. (2020), Kumari et. al., (2020), Funke et. al., (2022), Jansson et. al., (2024), there is potential for implementing a methane-based carbon tax. Carbon tax policies and carbon trading systems are policy instruments to achieve lower carbon emissions (Gao & Zhang, 2023). Implementation of a more comprehensive carbon tax, such as taxes on other gases besides CO_2 and a combination of taxes on products could help achieve higher emissions reduction targets (Nakano & Yamagishi, 2021) (Forero-Cantor dkk., 2020). In addition, a carbon tax will be more effective if implemented in conjunction with other mitigation technologies, such as anaerobic digestion at farm level, low nitrogen feed, flaxseed as a feed additive, nitrate as a feed additive, vaccination against methanogenic bacteria in the rumen, diet management and livestock management (Stepanyan et.al., 2023) (Kumari et. al., 2020). However, implementing a carbon tax is more suitable for developing countries, while a carbon trading system is more suitable for developed countries (Gao & Zhang, 2023). Although it is possible to implement a methane-based carbon tax, technology is needed to accurately measure methane emissions accompanied by an understanding of actors in the related field (Olczak dkk., 2022). Olczak dkk. (2022) also argue that a methane-based carbon tax cannot be implemented in the European Union due to the requirement of a unanimous decision in the European Union Commission. In research conducted by Olczak dkk. (2022), found that unsupportive regulations are one of the obstacles to implementing a methane-based carbon tax.

Is there potential to implement a carbon tax on the livestock sector?

Based on the articles reviewed, implementing a carbon tax in the livestock sector to address methane emissions could already be an option. The implementation of a carbon tax in the livestock sector can be carried out by considering various factors, such as type of livestock and carbon sequestration to avoid negative impacts on economic and environmental outcomes. (Horrillo dkk., 2021). Apart from that, the implementation of a carbon tax must also be accompanied by additional mitigation options so that emissions can be reduced significantly (Mittenzwei, 2020). A carbon tax could also help reduce emissions leakage, where production moves to other countries with looser regulations (Stepanyan dkk., 2023). Forero-Cantor et. al., (2020) adding that a carbon tax applied directly to the livestock sector along with taxes on certain animal products, could reduce overall emissions. Furthermore, educational programs for livestock farmers and economic incentives can increase the effectiveness of carbon taxes (Kumari dkk., 2020). Funke et. al., (2022) considers that livestock subsidies and stricter livestock standards can complement carbon tax policies in improving the sustainability of food systems. . Alvim & Sanguinet (2021) believes that the implementation of a carbon tax must be carried out without harming strategic industries, such as the beef industry. Implementing a carbon tax at a lower rate can minimize the negative impact of decreasing livestock production. A carbon tax can be applied to meat consumption because it is relatively easy to implement compared to other regulatory measures so that the carbon tax is imposed on consumers konsumen (Roosen et. al.,2022) (Funke et. al., 2022). This is in line with opinion Huang (2022) that a carbon tax applied to milk consumption imposes a burden on consumers. According to Yamamoto dkk. (2022), the implementation of a carbon tax in Vietnam could have a significant negative impact on GDP per capita which could hamper growth. The implementation of a carbon tax in the livestock sector will also face challenges or resistance from various parties, including livestock farmers and the public (Trewern dkk., 2022). Carbon taxes must be implemented not only in one country but applied globally so that they can reduce the risk of

carbon emissions moving to other countries. The carbon tax must also be ensured so that it does not burden small farmers or farmers in developing countries. Therefore, a mechanism is needed that supports the implementation of a carbon tax that does not harm the economy (Jansson et.al., 2024).

Is there potential to implement a methane-based carbon tax on the livestock sector in Indonesia?

Until now, Indonesia has not implemented a carbon tax, so the government needs to prepare various things to implement the carbon tax. Based on the articles reviewed, there is still little research discussing the implementation of a methane-based carbon tax in the livestock sector in the Southeast Asia region. In fact, there are no articles discussing the implementation of a methane-based carbon tax in the livestock sector in Indonesia. Until now, there are only two regulations governing the implementation of carbon tax, namely Law Number 7 of 2021 concerning Harmonization of Tax Regulations and Presidential Regulation Number 98 of 2021.

The benefits of implementing a carbon tax on methane emissions are very significant in reducing carbon emission levels. Roosen et. Al.,. (2022) said that a high carbon tax could result in greater reductions in greenhouse gas emissions. Forero-Cantor dkk. (2020) also supports this statement, arguing that policies are needed to reduce emissions from the livestock sector through a carbon tax that is applied directly to the livestock sector. From several studies conducted, the potential for implementing a methane-based carbon tax in the livestock sector can be implemented through appropriate regulatory support by considering various factors.

Another form of implementing a carbon tax to reduce emissions can be done through mitigation technology, such as anaerobic digestion at the farm level, low nitrogen feed, flaxseed as a feed additive, nitrate as a feed additive, and vaccination against methanogenic bacteria in the rumen (Stepanyan et. al., 2023) (Kumari et. al., 2020). Xu et. al., (2023) also added that encouraging mixed farming practices (*Coupling of Crop and Livestock Production* – CCLP) where waste from livestock is used as fertilizer for plants, and agricultural products are used as animal feed to improve the nutrient cycle and reduce dependence on synthetic fertilizers. Increasing the use of manure as an alternative to synthetic fertilizers can also help reduce emissions, improve soil quality, and increase biodiversity. Nehra & Jain (2023) said that replacing fossil fuels, such as diesel, with biogas produced from livestock waste and utilizing livestock waste as natural gas for cooking and for generating electricity is also one of the steps in sustainable environmental development (Islam dkk., 2021). By utilizing biogas, CO emissions$_2$ and other greenhouse gases can be minimized, because biogas is a cleaner and renewable energy source. The government needs to conduct in-depth studies into implementing a carbon tax or other options that can be implemented, such as mitigation technology. This is due to research conducted by Yamamoto dkk. (2022) which states that carbon taxes can have a significant negative impact on GDP per capita which hinders economic growth, especially in developing countries.

CONCLUSION

As one of the contributors to greenhouse gas emissions produced by humans, methane emissions produced by the livestock sector are something that must be addressed immediately. The government plays an important role in implementing environmental sustainability policies. A carbon tax, a form of Pigouvian tax, could be one possible solution to overcome this problem. Research shows that there is potential for implementing a methane-based carbon tax and there is potential for implementing a carbon tax in the livestock sector. However, the potential for implementing a methane-based carbon tax in the livestock sector in Indonesia cannot yet be implemented directly because there is no clear and comprehensive regulatory framework. This is demonstrated by the postponement of the implementation of the carbon tax until 2025.

The implementation of a carbon tax needs to consider various aspects so that it does not have a negative impact on the Indonesian economy. Therefore, alternative methods are needed to deal with methane emissions. Livestock mitigation technologies, such as diet management and livestock management, livestock subsidies, and stricter livestock standards are other approaches that could be considered in reducing methane emissions. The implementation of a carbon tax will be faced with resistance by society. Thus, policies must be well designed and well communicated so that they can be accepted by society and create a sustainable environment.

Research Limitations

The researcher experienced limitations in this research because the researcher only used articles of a certain nature *open access* thereby reducing the scope of the study. This allows other, more relevant articles to be studied related to the research topic. The selection of journals that mostly discuss tax implementation in European Union countries could also produce different results if implemented in Indonesia. Researchers also have not compared in detail the ideal practices for implementing carbon taxes on methane in other countries with existing regulations in Indonesia. The government's readiness to implement a methane-based carbon tax in the livestock sector is also one of the things that was not considered in this research.

Suggestion

The implementation of a methane-based carbon tax in the livestock sector has great potential. However, in its implementation, the Directorate General of Taxes and the Fiscal Policy Agency must carry out comprehensive assessments and studies to achieve an in-depth understanding of the sensitivity of implementing carbon tax policies in the Indonesian livestock sector. Future research is recommended to include broader studies by conducting case studies in several regions in Indonesia and considering other aspects that have not been covered in this research, considering the different conditions in the livestock industry in various regions of Indonesia. Further research can also be carried out by calculating the potential tax revenue that the Indonesian government will receive if it implements a methane-based carbon tax in the livestock sector and calculating the impact of tax regulations on welfare and economic growth in Indonesia.

REFERENCES

Adegbeye, M. J., Elghandour, M. M. M. Y., Monroy, J. C., Abegunde, T. O., Salem, A. Z. M., Barbabosa-Pliego, A., & Faniyi, T. O. (2019). Potential influence of Yucca extract as feed additive on greenhouse gases emission for a cleaner livestock and aquaculture farming - A review. *Journal of Cleaner Production*, *239*, 118074. https://doi.org/10.1016/j.jclepro.2019.118074

Alvim, A. M., & Sanguinet, E. R. (2021). Climate Change Policies and the Carbon Tax Effect on Meat and Dairy Industries in Brazil. *Sustainability*, *13*(16), 9026. https://doi.org/10.3390/su13169026

Amoo, L. M., & Layi Fagbenle, R. (2020). Climate change in developing nations of the world. Dalam *Applications of Heat, Mass and Fluid Boundary Layers* (hlm. 437–471). Elsevier. https://doi.org/10.1016/B978-0-12-817949-9.00023-2

Andersson, J. J. (2019). Carbon Taxes and CO2 Emissions: Sweden as a Case Study. *American Economic Journal: Economic Policy*, *11*(4), 1–30. https://doi.org/10.1257/pol.20170144

Baranzini, A., van den Bergh, J. C. J. M., Carattini, S., Howarth, R. B., Padilla, E., & Roca, J. (2017). Carbon pricing in climate policy: seven reasons, complementary instruments, and political economy considerations. *WIREs Climate Change*, *8*(4). https://doi.org/10.1002/wcc.462

Carattini, S., Carvalho, M., & Fankhauser, S. (2018). Overcoming public resistance to carbon taxes. *WIREs Climate Change*, *9*(5). https://doi.org/10.1002/wcc.531

Cheng, M., McCarl, B., & Fei, C. (2022). Climate Change and Livestock Production: A Literature Review. *Atmosphere*, *13*(1), 140. https://doi.org/10.3390/atmos13010140

Crutzen, P. J., Aselmann, I., & Seiler, W. (1986). Methane production by domestic animals, wild ruminants, other herbivorous fauna, and humans. *Tellus B: Chemical and Physical Meteorology*, *38*(3–4), 271. https://doi.org/10.3402/tellusb.v38i3-4.15135

Forero-Cantor, G., Ribal, J., & Sanjuán, N. (2020). Levying carbon footprint taxes on animal-sourced foods. A case study in Spain. *Journal of Cleaner Production*, *243*, 118668. https://doi.org/10.1016/j.jclepro.2019.118668

Funke, F., Mattauch, L., Bijgaart, I. van den, Godfray, H. C. J., Hepburn, C., Klenert, D., Springmann, M., & Treich, N. (2022). Toward Optimal Meat Pricing: Is It Time to Tax Meat Consumption? *Review of Environmental Economics and Policy*, *16*(2), 219–240. https://doi.org/10.1086/721078

Gao, X., & Zhang, Y. (2023). Feasibility Study of China's Carbon Tax System under the Carbon Neutrality Target—Based on the CGE Model. *Sustainability*, *15*(2), 1026. https://doi.org/10.3390/su15021026

Grossi, G., Goglio, P., Vitali, A., & Williams, A. G. (2019). Livestock and climate change: impact of livestock on climate and mitigation strategies. *Animal Frontiers*, *9*(1), 69–76. https://doi.org/10.1093/af/vfy034

Horrillo, A., Gaspar, P., Díaz-Caro, C., & Escribano, M. (2021). A scenario-based analysis of the effect of carbon pricing on organic livestock farm performance: A case study of Spanish dehesas and rangelands. *Science of The Total Environment*, *751*, 141675. https://doi.org/10.1016/j.scitotenv.2020.141675

Huang, W. (2022). Demand for plant-based milk and effects of a carbon tax on fresh milk consumption in Sweden. *Economic Analysis and Policy*, *75*, 518–529. https://doi.org/10.1016/j.eap.2022.06.011

International Energy Agency. (2022). *Global Methane Tracker 2022*.

Islam, K. N., Sarker, T., Taghizadeh-Hesary, F., Atri, A. C., & Alam, M. S. (2021). Renewable energy generation from livestock waste for a sustainable circular economy in Bangladesh. *Renewable and Sustainable Energy Reviews*, *139*, 110695. https://doi.org/10.1016/j.rser.2020.110695

Jansson, T., Malmström, N., Johansson, H., & Choi, H. (2024). Carbon taxes and agriculture: the benefit of a multilateral agreement. *Climate Policy*, *24*(1), 13–25. https://doi.org/10.1080/14693062.2023.2171355

Kallbekken, S., Kroll, S., & Cherry, T. L. (2011). Do you not like Pigou, or do you not understand him? Tax aversion and revenue recycling in the lab. *Journal of Environmental Economics and Management*, *62*(1), 53–64. https://doi.org/10.1016/j.jeem.2010.10.006

Kumari, S., Fagodiya, R. K., Hiloidhari, M., Dahiya, R. P., & Kumar, A. (2020). Methane production and estimation from livestock husbandry: A mechanistic understanding and emerging mitigation options. *Science of The Total Environment*, *709*, 136135. https://doi.org/10.1016/j.scitotenv.2019.136135

Li, M., Liu, S., Sun, Y., & Liu, Y. (2021). Agriculture and animal husbandry increased carbon footprint on the Qinghai-Tibet Plateau during past three decades. *Journal of Cleaner Production*, *278*, 123963. https://doi.org/10.1016/j.jclepro.2020.123963

McDonnell, F. (2024, November 22). *Denmark to introduce new 'emissions from livestock' tax from 2030*. Agriland. https://www.agriland.ie/farming-news/denmark-to-introduce-new-emissions-from-livestock-tax-from-2030/

Mittenzwei, K. (2020). Greenhouse Gas Emissions in Norwegian Agriculture: The Regional and Structural Dimension. *Sustainability*, *12*(6), 2506. https://doi.org/10.3390/su12062506

Montzka, S. A., Dlugokencky, E. J., & Butler, J. H. (2011). Non-CO2 greenhouse gases and climate change. *Nature*, *476*(7358), 43–50. https://doi.org/10.1038/nature10322

Mutrofi'ah, A. (2023, Oktober 9). *Pajak Karbon, Solusi Polusi Udara*. Direktorat Jenderal Pajak. https://pajak.go.id/id/artikel/pajak-karbon-solusi-polusi-udara

Nafi'ah, Z. Z., & Dinarjito, A. (2024). Analysis of the potential of implementing methane-based carbon tax on food waste in Indonesia. *Educoretax*, *4*(7), 851–871. https://doi.org/10.54957/educoretax.v4i7.974

Nakano, K., & Yamagishi, K. (2021). Impact of Carbon Tax Increase on Product Prices in Japan. *Energies*, *14*(7), 1986. https://doi.org/10.3390/en14071986

National Climate Change Secretariat. (t.t.). *Carbon Tax*. National Climate Change Secretariat. Diambil 29 November 2024, dari https://www.nccs.gov.sg/singapores-climate-action/mitigation-efforts/carbontax/#:~:text=The%20carbon%20tax%20level%20was,period%20for%20emitters%20to%20adjust.&text=To%20support%20our%20net%20zero,e%20with%20effect%20from%202024.

Nehra, M., & Jain, S. (2023). Estimation of renewable biogas energy potential from livestock manure: A case study of India. *Bioresource Technology Reports*, *22*, 101432. https://doi.org/10.1016/j.biteb.2023.101432

Olczak, M., Piebalgs, A., & Balcombe, P. (2022). Methane regulation in the EU: Stakeholder perspectives on MRV and emissions reductions. *Environmental Science & Policy*, *137*, 314–322. https://doi.org/10.1016/j.envsci.2022.09.002

Reyseliani, N., Hidayatno, A., & Purwanto, W. W. (2022). Implication of the Paris agreement target on Indonesia electricity sector transition to 2050 using TIMES model. *Energy Policy*, *169*, 113184. https://doi.org/10.1016/j.enpol.2022.113184

Roosen, J., Staudigel, M., & Rahbauer, S. (2022). Demand elasticities for fresh meat and welfare effects of meat taxes in Germany. *Food Policy*, *106*, 102194. https://doi.org/10.1016/j.foodpol.2021.102194

Shakoor, A., Shakoor, S., Rehman, A., Ashraf, F., Abdullah, M., Shahzad, S. M., Farooq, T. H., Ashraf, M., Manzoor, M. A., Altaf, M. M., & Altaf, M. A. (2021). Effect of animal manure, crop type, climate zone, and soil attributes on greenhouse gas emissions from agricultural soils—A global meta-analysis. *Journal of Cleaner Production*, *278*, 124019. https://doi.org/10.1016/j.jclepro.2020.124019

Shi, R., Irfan, M., Liu, G., Yang, X., & Su, X. (2022). Analysis of the Impact of Livestock Structure on Carbon Emissions of Animal Husbandry: A Sustainable Way to Improving Public Health and Green Environment. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.835210

Stepanyan, D., Heidecke, C., Osterburg, B., & Gocht, A. (2023). Impacts of national vs European carbon pricing on agriculture. *Environmental Research Letters*, *18*(7), 074016. https://doi.org/10.1088/1748-9326/acdcac

Thangarajan, R., Bolan, N. S., Tian, G., Naidu, R., & Kunhikrishnan, A. (2013). Role of organic amendment application on greenhouse gas emission from soil. *Science of The Total Environment*, *465*, 72–96. https://doi.org/10.1016/j.scitotenv.2013.01.031

Trewern, J., Chenoweth, J., & Christie, I. (2022). "Does it change the nature of food and capitalism?" Exploring expert perspectives on public policies for a transition to 'less and better' meat and dairy. *Environmental Science & Policy*, *128*, 110–120. https://doi.org/10.1016/j.envsci.2021.11.018

United Nations Climate Change. (2014, Agustus 7). *Why Methane Matters*. United Nations Climate Change. https://unfccc.int/news/new-methane-signs-underline-urgency-to-reverse-emissions

World Bank. (2024). *State and Trends of Carbon Pricing Dashboard*. World Bank. https://carbonpricingdashboard.worldbank.org/compliance/price

Xu, X., Xu, Y., Li, J., Lu, Y., Jenkins, A., Ferrier, R. C., Li, H., Stenseth, N. C., Hessen, D. O., Zhang, L., Li, C., Gu, B., Jin, S., Sun, M., Ouyang, Z., & Mathijs, E. (2023). Coupling of crop and livestock production can reduce the agricultural GHG emission from smallholder farms. *iScience*, *26*(6), 106798. https://doi.org/10.1016/j.isci.2023.106798

Yamamoto, A., Huynh, T. K. U., Saito, Y., & Matsuishi, T. F. (2022). Assessing the costs of GHG emissions of multi-product agricultural systems in Vietnam. *Scientific Reports*, *12*(1), 18172. https://doi.org/10.1038/s41598-022-20273-w