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Decarbonising meat: exploring greenhouse gas emissions in the meat sector

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Abstract

Consumption of meat is an important source of global greenhouse gas (GHG) emission and deep decarbonisation of the whole meat production chain is required to be able to meet global climate change (CC) mitigation goals. Emissions happen in different stages of meat production ranging from agricultural input production, feed production, livestock production to slaughtering, meat processing, and retail. An overview of direct emissions from processes in the meat sector themselves and indirect emissions from energy consumptions would provide a clearer picture for potential CC impact reduction. This paper explores the total GHG emissions and data availability within the meat sector of the pig, chicken, and cattle meat product system. Through statistical data provided by FAOSTAT and supplementary data from literature, the CC impacts of energy use and process GHG emissions in the pig, chicken and cattle meat life cycle are estimated. Cattle dominates, but pig and chicken meat have a sizable amount of GHG emissions with a relatively high contribution from agricultural inputs and post-farm processes. However, uncertainty and unavailability of data are large for the energy consumption, direct GHG emissions, and product flows of post-farm and agricultural input processes. In order to gain a more complete understanding of the total CC impacts of the meat sector, further research is necessary to reduce the uncertainty in the considered life cycle stages and to quantify the processes and meat products that have been excluded from this study.

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Keywords: Meat sector; decarbonisation; climate change; greenhouse gases; energy use

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1. Introduction

Consumption of meat is an important source of global greenhouse gas (GHG) emission. Therefore, deep decarbonisation of the whole meat product system is required to meet global climate change (CC) mitigation goals. The global livestock production chain was estimated to be about 7 Gt CO2-eq [1] in 2005 with an update in process estimating emissions in 2010. However, the calculations and sources are not always transparent and it is clear that updates require significant time.

Instead, basing calculations on global statistical data could improve transparency and reduce data gathering efforts. This improvement is limited by aggregated statistical data for pre- and post-agricultural emissions into different industry categories or a lack of data, though literature may be used to estimate these based on statistical data.

This paper explores the data availability of total process GHG emissions and energy consumption of the pork, chicken, and beef. The results are an initial estimation of total global GHG emissions of the meat sector and an overview of the data availability within the product system.

2. Methods

The global CC of the meat sector from a life cycle perspective was quantified using statistical data and literature data (fig. 1). This study includes GHG emissions resulting from processes in the life cycle stages and from energy consumption, though it excludes emissions and energy for the production of other material inputs. Statistical data from FAOSTAT [6] and IEA were used to determine global energy use, CO_2, CH_4, and N_2O emissions when available. Literature was used to estimate values where statistical data gaps exist.

The calculation of CC impact requires the conversion of GHG emissions into CO_2-eq using the GWP_{100} factors defined by IPCC AR5 [2]. To convert energy data into CO_2 emissions, IEA [3,4] data on GHG emissions were linked to data on total primary energy, fuel, oil, natural gas, and electricity consumption (table 1). When the energy source for energy consumption is explicitly given, or can be inferred, the corresponding emissions per energy unit are assigned to calculate GHG emissions. For unspecified energy sources, the total fuel consumption values are taken instead, as it represents the total energy and emissions of all fossil fuel combustion combined.

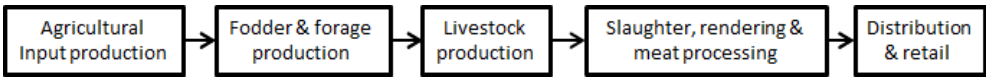

Fig 1: Life cycle stages of the meat sector product system

Table 1: Total primary energy and total fuel, oil and electricity consumption with related GHG emissions from combustion in 2014

Energy type	Energy [a]	GHG emissions [b]	Emissions per energy unit
	PJ	Mt CO2-eq	Mt CO2-eq per PJ
Total primary energy	573,550	32,381	0.06
Total fuel	394,606	32,381	0.08
Oil	157,448	10,973	0.07
Natural gas	59,585	6,363	0.11
Electricity and heat	99483	13,625	0.14

[a] Data from [3], [b] Data from [4]

3. Results and Discussion

3.1. Synthetic fertilizer and pesticide production

Synthetic fertilizers are dominated by nitrogen, phosphorus and potassium fertilizers, either as a single substance or in various combinations. The main source of nitrogen is the Haber-Bosch process producing NH_3 which can be