Life Cycle Assessment methodology to evaluate environmental impact of beef manure management: a comparison.

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Introduction

- To reduce GHG emissions through manure management we can implement a variety of systems.
- Comparsions should be made in order to determine greatest emissions and different stage´s contribituon to them.
- For this, Life Cycle Assessment (LCA) is one of the most robust methodologies.

Methods

We compared peer-reviewed LCA studies that reported at least GHG emissions through out the management of beef feedlot manure. For this we:

- Standardized total emissions to 1 ton of dry basis manure
- Stablished 4 stages of manure management systems and recorded which studies included them (feedlot, transport, storage/transformation & use)
- Made comparison between emissions obtained and purpose of transformation

Results

- Final review included 19 scenarios evaluated (2007-2021), 12 were focused on energy generation.
- The energetic evaluations represented both, the most (E3) and the least emissions (E7) through the whole process.
- Only 21.4% of all the LCAs considered in this study included all four stages of manure management.
- Emissions ranges between different manure management systems can be as high as 4,000X.
- Composting showed to have more emissions than stockpiling and simple fertilizing practices.

Discussion

- Bioenergetic processes are the least emission generators when given environmental credits.
- Composting and stockpiling aren´t perceived as innovative solutions when aiming to mitigate emissions, but should be optimized as well, since they´re the most applied techniques for feedlot manure management.
- Authors report that storage (Lansche *et al,* 2012) and transportation (Van Stappen *et al,* 2016) are main emission sources, hence they should be considered in evaluations.
- The differences in emissions between manure management systems is influenced by system boundaries, allocation procedures, emission factors, environmental credits, amongst others.

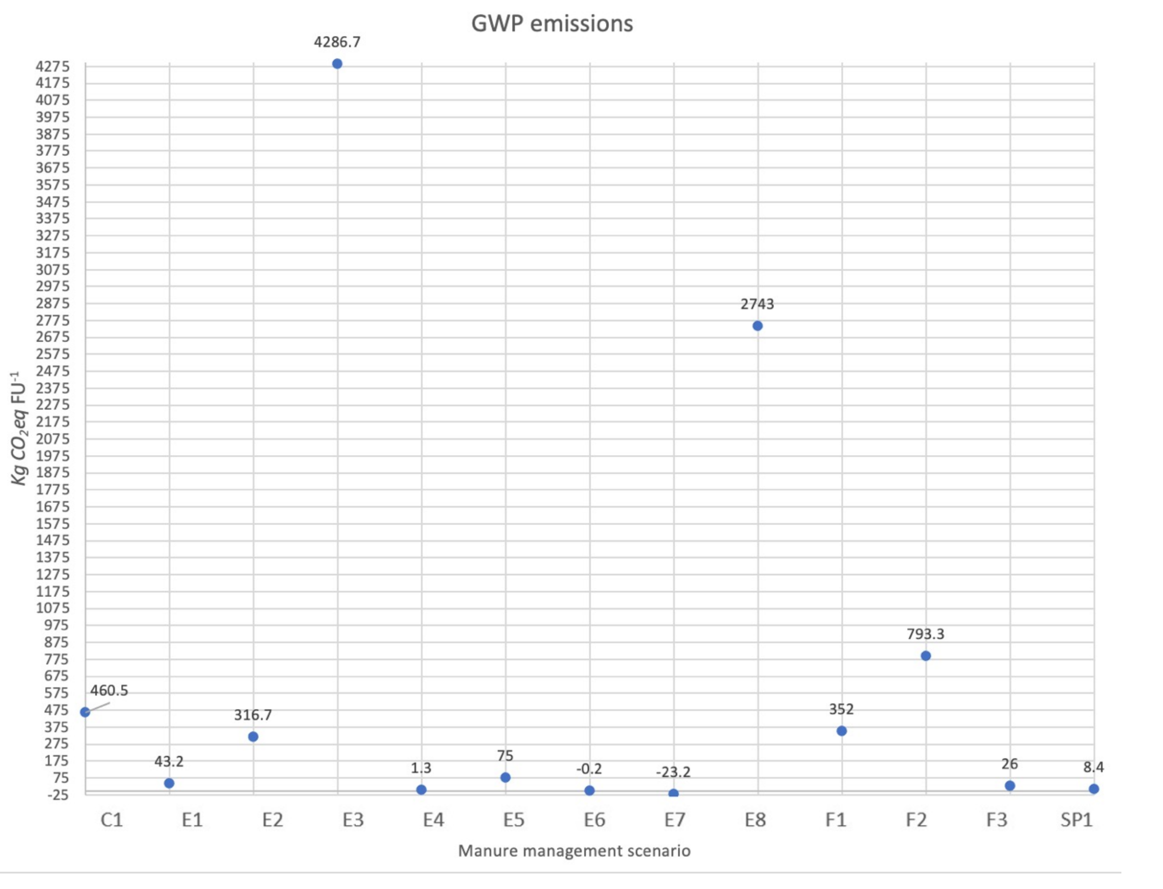
Bioenergy generation was the manure management stategy that emitted the most GHGs in beef feedlot production, therefore its mitigation potential comes from the substitution of other energetic sources.

Graphics

Table 1. Publications covered by this review, emissions per ton of dry manure and stages of manure management covered.

Reference	GWP	Function	Stages of manure management included in LCA			
	Kg CO_2eq		*Feedlot*	*Transport*	*Storage/transformation*	*Use/disposal*
Ghafoori *et al*, 2007	26	F	X	X	X	X
Ghafoori *et al*, 2007	75	E	X	X	X	X
Beauchemin *et al*, 2010	*	F	X	X		
Lansche & Müller, 2012	-0.2	E		X	X	X
Poeschl *et al*, 2012	-23.2	E		X	X	X
Boulamanti *et al*, 2013	2743	E		X	X	X
Wu *et al*, 2013	793.3	F	X	X	X	X
Wu *et al*, 2013	4286.7	E	X	X	X	X
Redding *et al*, 2015	460.5	C			X	
Redding *et al*, 2015	8.4	SP			X	
Van Stappen *et al*, 2016	*	E	X	X	X	X
Azevedo *et al*, 2017	1.3	E			X	
Giwa, 2017	*	E		X	X	X
Russo & Blottniz, 2017	*	E			X	
Aui *et al*, 2019	43.2	E			X	
Aui *et al*, 2019	316.7	E			X	
Heflin *et al*, 2019	352	F		X	X	
Ogino *et al*, 2021	*	SP	X	X	X	X
Ogino *et al*, 2021	*	E	X	X	X	

Figure 1. Results of GHG emission standardized to 1 ton of dry manure.



C1: Redding *et al*, 2015. E1: Aui *et al*, 2019. E2: Aui *et al*, 2019. E3: Wu *et al*, 2013. E4: Azevedo *et al*, 2017. E5: Ghafoori *et al*, 2007. E6: Lansche & Müller, 2012. E7: Poeschl *et al*, 2012
E8: Boulamanti *et al*, 2013. F1: Heflin *et al*, 2019. F2: Wu *et al*, 2013. F3: Ghafoori *et al*, 2007.
SP1: Ogino *et al*, 2021.
FU: Functional Unit: 1 ton of manure dry basis.

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