GREENHOUSE GASES IN LIVESTOCK FARMING: THE CASE STUDY IN FLECKVIEH CATTLE IN THE PERUVIAN AMAZON

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INTRODUCTION

Small-scale production of milk and beef is crucial for the economy and food security. However, mitigating its environmental impact requires the implementation of sustainable practices. The carbon footprint (CF) framework, which estimates the greenhouse gas (GHG) emissions throughout a product or service's life cycle, serves as a crucial tool in this regard. Therefore, this study aimed to quantify the GHG emissions in four Fleckvieh production systems distributed in the Peruvian Amazon region.

MATERIAL AND METHODS

- **Location:** Amazon region, Peru.
- **Subareas:** Chachapoyas (System I; n = 2), Bongara (System II; n = 4), Rodriguez de Mendoza (System III; n = 2), and Utcubamba (System IV; n = 2).
- **Data collection:** A survey with 55 farmers.
- **Goal and scope:** From "cradle-to-farm gate" (Fig. 1).
- **Methodology:** Guidelines of Intergovernmental Panel on Climate Change (2019).
- **Statistical analysis:**

Comparison between systems was done using Duncan's statistical test ($p<0.05$). Additionally, correlation analysis was performed using Pearson correlation (r) in SPSS software.

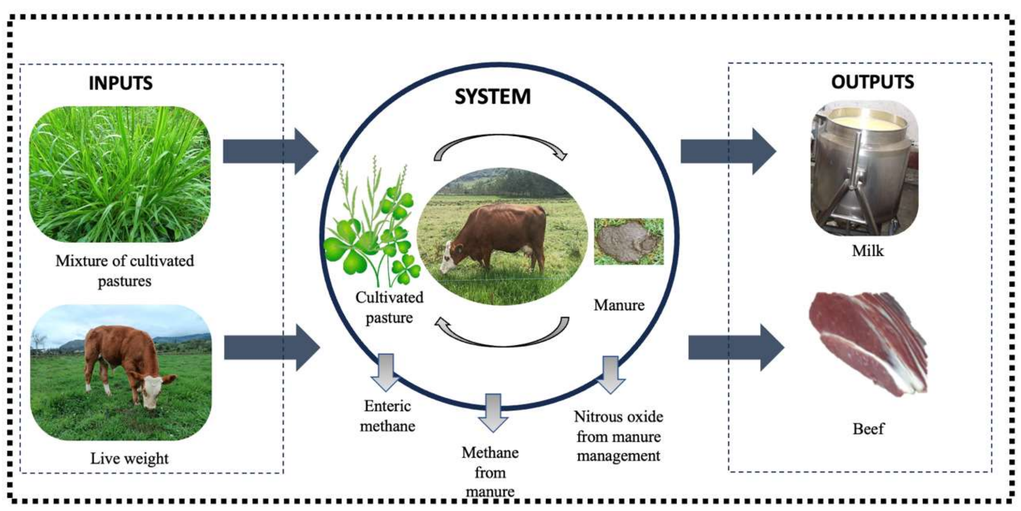

Fig. 1. System boundaries on Fleckvieh cattle farms using a "cradle-to-farm gate" approach.

RESULTS

- An average CF of 1.72 and 2.53 kg CO_2eq/kg of fat and protein-corrected milk (FPCM) according to mass and economic allocation.
- Enteric methane (90.8 %) emissions, followed by nitrous oxide from manure management (6.9%) (Fig. 2).
- The system I (67.7 kg CH_4/kg of FPCM) exhibited the lowest enteric emissions than Systems II (93.6 kg CH_4/kg of FPCM) and IV (89.1 kg CH_4/kg of FPCM) (Table 1).
- Positive correlations were found between CH_4 emissions with total FPCM, animal units, lactating cows, and low-producing animals (all categories except lactating cows) (Table 2).

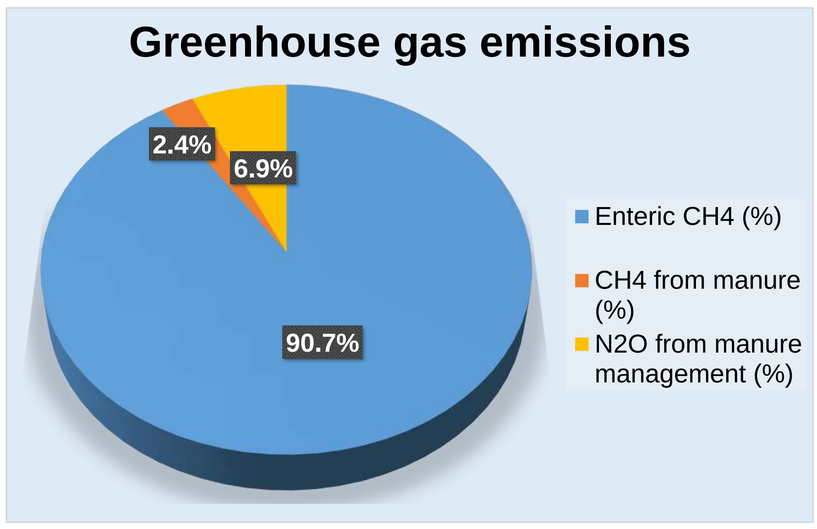

Fig. 2. Percentage of greenhouse gas emissions in the Fleckvieh cattle production systems of the Amazon region.

Table 1. Greenhouse gas emission factors (Mean ± standard deviation) according to the system in the Amazon region.

System	Enteric CH_4 (kg CH_4/AU/year)	CH_4 from manure (kg CH_4/AU/year)	N_2O from manure management (kg N2O/AU/year)
System I	67.7 ± 6.1[b]	1.6 ± 0.4[a]	0.7 ± 0.2 [a]
System II	93.6 ± 7.5[a]	2.8 ± 0.5 [a]	0.8 ± 0.1 [a]
System II	76.2 ± 12.8[ab]	2.1 ± 0.5 [a]	0.7 ± 0.0 [a]
System IV	89.1 ± 3.5[a]	2.3 ± 0.1 [a]	0.9 ± 0.0 [a]
P-value	0.04	0.08	0.25

Comparison of means with the Duncan test at the level of p = 0.05. CH_4: Methane; N_2O: Nitrous oxide; AU: Animal unit.

Table 2. Pearson correlation coefficients for the factors used to estimate the partial carbon footprint in the Fleckvieh cattle systems in the Peruvian Amazon.

	CH_4E	CH_4M	N_2OMM	LC	LPA	TAU	DMI.AU	FPCM t
CH_4E	1	0.99**	0.99**	0.95**	0.97**	0.99**	0.08	0.94**
CH_4M		1	0.96**	0.91**	0.96**	0.97**	0.10	0.90**
N_2OMM			1	0.96**	0.96**	0.99**	0.06	0.95**
LC				1	0.87**	0.95**	-0.13	0.99**
LPA					1	0.98**	0.30	0.87**
TAU						1	0.13	0.95**
DMI.AU							1	-0.10
FPCM t								1

CH_4E: Enteric methane; CH_4M: Methane from manure (Kg CO_2e/kg FPCM); N_2OMM: Nitrous oxide from manure management (Kg CO_2e/kg FPCM); LC: Lactating cows; LPA: Low-producing animals; TAU: Total of animal units; DMI.AU: dry matter intake per animal unit (kg/AU); FPCM t: Fat and protein-corrected milk per farm (t/farm/year).

CONCLUSIONS

- Our study highlights the need to optimize herd composition, increase production levels, and decrease low-producing animals (steers, male and female calves, and dry cows) to reduce the carbon footprint.
- Improving the forage nutritive value can increase milk production, securing the economic well-being of smallholder farmers and the sustainability of the farming sector in the Peruvian Amazon.

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