Analysis of the environmental footprint of France – Italy integrated beef production system with a LCA approach

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Introduction

North East Italy beef sector is included in a two-steps livestock farming system

- Geographical separeted
- Based on different production system and outputs

Introduction

In Italy 2/3 of the beef cattle are reared in northern regions by **intensive fatteners** that import calves, mainly from France, and fed until slaughter with TMR based on **maize silage and concentrates**.

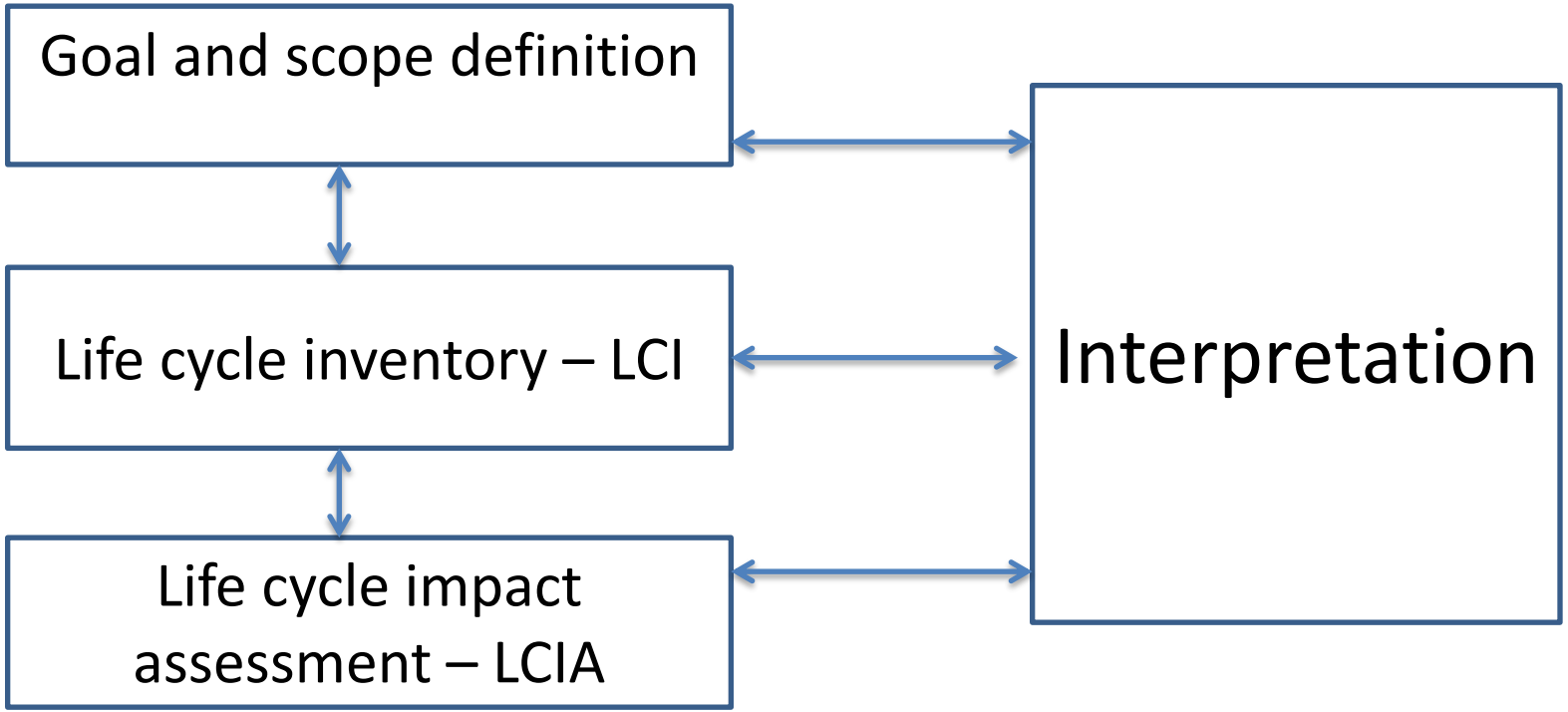
- Growing concern for **environmental sustainability** of intensive systems

Aims

This study aimed to examine the environmental footprint of intensive beef sector of North East Italy through a cradle-to-farm-gate Life Cycle Assessment (LCA)

- suckler cow-calf farms in France (literature review) and intensive fattening farms in Italy (on farm survey)

Life Cycle Assessment (LCA) phases



Goal and Scope Definition

- Batch as reference unit (groups of stock calves homogeneous for genetic type, origin, finishing herd and fattening period)
- Functional unit: 1 kg of Body Weight (BW) gained

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- Allocation: mass allocation for inputs derived by multifunctional systems, no allocation for farm outputs

System Boundaries

Cradle-to-gate literature data for French suckler cow-calf farms (Nguyen et al, 2012)

- Herd modelled on “Charolais Beef Cattle Farm Networks” of the French Livestock Institute
- 70 suckler cows, 62 weaned calves, in February and weaned at 9 months
- Grassland zone of the Charolais basin classified as extensive systems with 1.2 livestock units per ha of forage area and 7.5 months grazing from April to November.

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Gate-to-gate survey for North East Italy farms

- from the arrival of batch at fattening farm to its sale to slaughterhouse

Life Cycle Inventory (LCI) – Italian farms

- Collection of general data on farm facilities and management for year 2013
  - 197 Charolais-breed batches
  - 15 specialized beef fatteners

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- Recording of speficic data:
  - Growth performance, at batch level
  - Diet composition, at farm level
  - Crop production: agricultural inputs for on-farm feeds, at farm level
  - Off-farm materials used on farm

Life Cycle Inventory (LCI) – Italian farms

- Emission calculation methods:
  - IPCC Tier 1 (crop production) and Tier 2 (animal handling)
  - Emission factors were derived from EcoInvent 3.0 and Agri-footprint databases (off-farm inputs)

Life Cycle Impact Assessment (LCIA)

Impact Categories studied:

- Greenhouse Gases emission (GHG, kg CO_2-eq/ kg BW gained)
- Eutrophication Potential (EP, g PO_4-eq / kg BW gained)

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Total emission from calf birth to the end of fattening: impact categories/ kg BW gained

French sukler cow-calf farms

Kg BW at sale (kg BW/ batch) * emission values (impact categories / kgBW gained)

+

Italian fattening farms

Total emission per batch per impact category / total BW gained at farm gate

Statistical Analysis

PROC MIXED according to the following model:

$$y_{ijklm} = \mu + H_i + ADG_j + NDF_k + BW_l + AS_m + e_{ijklm}$$

H = farm(random, 14 herds);
ADG = average daily gain (kg/d) class (3 classes based on SD);
NDF = neutral detergent fiber level (%DM) class (3 classes);
BW= arrival body weight class (3 classes);
AS = arrival season (4 seasons).

Results: Italian farms performance

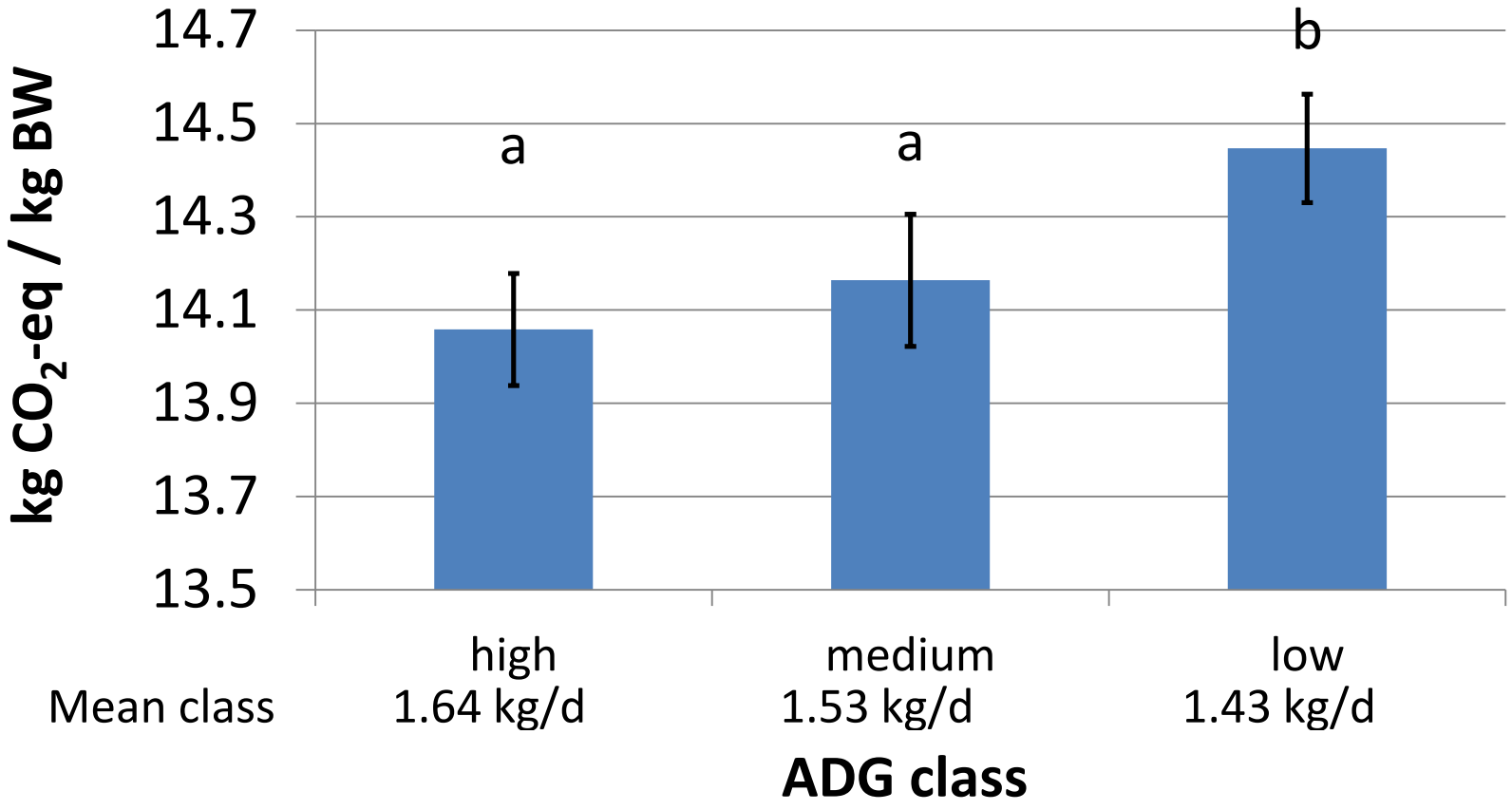
Variable	Unit	Mean	CV
heads / batch	N	66	0.48
Initial BW	kg	392	0.06
Final BW	kg	734	0.03
duration	d	225	0.08
DMI	kgDM/d	10.3	0.07
ADG	kg/d	1.53	0.06
CP	% DM	13.1	0.08
P	% DM	0.4	0.25
NDF	% DM	33.3	0.08

BW: body wieght; DMI: dry matter intake; ADG: average daily gain; CP: crude protein; P: phosphorous; FG: ; EE: Ether Extract; NDF: neutral detergent fibre

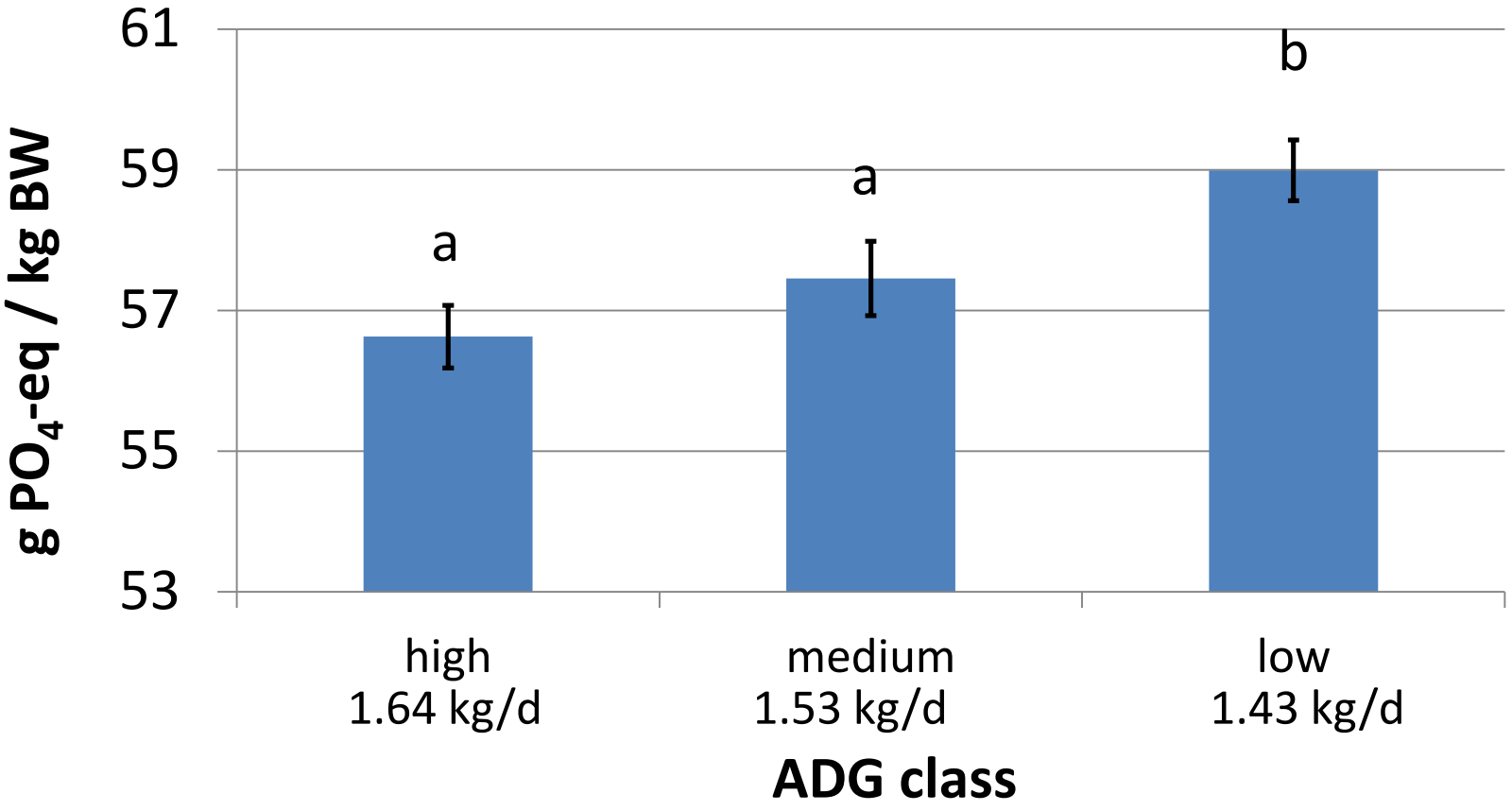
Results: France-Italy beef sector emissions

Variables	GHG emission kg CO_2-eq/ kg BW		Eutrophication g PO_4-eq / kg BW	
	Mean	SD	Mean	SD
French suckler cow-calf farms	17.5		62	
Italian fattening farms	7.2	1.1	65	11
Total French-Italian beef system	14.3	0.8	63	5
Fraction due to Italian fattening farms	0.27	0.04	0.50	0.05
Literature range of impact	7.6 -19.2		54 - 215	

LSmeans for GHG emission



LSmeans for Eutrophication



Conclusion

- France-Italy integrated beef chain is a great player in the European beef system
- The average enviromental impact for GHG emisisson and Eutrophication is comparable to other studies
- The efficiency of growth performance stronlgy affects the environmental impact of beef production

Perspectives

- The cow-calf phase will be further investigated to analyse the variability of impact categories and the ecosystems services provided by animal grazing, with the perspective to obtain a holistic evaluation of the sustainability of the integrated France – Italy beef production system.

- Impact categories assessed will be further extended considering also acidification, energy use and land occupation

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Thank you for attention

Multi-breed results - Italian fattening farms

Impact category	Unit	Reference	Mean	SD	Min	Max
GW [1]	Kg CO_2-eq/kg BW	IPCC, 2006	7.7	1.3	4.6	11.0
		Ellis *et al.*, 2007	8.2	1.5	4.7	12.5
		Moraes *et al.*, 2004	8.7	1.5	5.2	12.8
AC [2]	g SO_2-eq/kg BW	IPCC, 2006	198	32	136	297
		EEA, 2010	155	31	90	239
		ISPRA, 2011	141	26	85	205
EU [3]	g PO_4-eq/kg BW	IPCC, 2006 Nemecek and Kagi, 2007	66	12	40	96
CED [4]	MJ/kg BW		54	14	21	82
LO [5]	m2/kg BW		8.9	1.7	5.5	13.1

SD: Standard Deviation [1] GW: Carbon footprint. [2] AC: Acidification. [3] EU: Eutrophication. [4] CED: Cumulative Energy Demand. [5] LO: Land Occupation

		GHG emission kg CO2 / kg BW	Eutrophication g PO4 / kg BW
Nguyen et al., 2012	fattening with maize silage	8.6	32
Nguyen et al., 2012	suckler cow-calf + fattening bulls	15.3 - 15.9	54-56
Pelletier et al., 2010	feedlot	8.3	57
Pelletier et al., 2010	suckler cow-calf + feedlot system	14.8	104