Mitigation of methane emissions in beef cattle using bioeconomic models

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ABSTRACT

This work shows an approach of bio economic models to include CH4 mitigation in beef cattle breeding goal. Three different scenarios were developed: i. Current replacement index for Blonde d´Aquitaine "Current situation"; ii. Carbon tax; iii. Establishment of a methane quota per farm. Data on 4,573 cows and 7,498 calves from the National Association of Blonde d'Aquitaine were used to estimate CH4 kg per year per unit of product (slaughtered calf). Economic weights were estimated under the three scenarios using a bio economic model, which led to three selection indices accounting for three groups of traits, functional, production and (for scenarios ii and iii) methane traits. For Scenario 1, functional and production traits accounted for 48 and 52% of the economic importance. For scenario 2, methane traits supposed 4.6% of the economic importance, whereas functional and production economic importances had a relative weight of 49.2 and 46.2%, respectively. Relative importance of methane was lower in scenario 3 (1.8%); in contrast to the enhanced weight for production traits (52.4%). The importance on functional traits decreased to 45.8% in a quota situation.

The expected economic response in scenario 1 was 69.1€/year (97% of this was from production traits and 3% from functional traits). This expected genetic gain would decrease to +65.3€/year if a penalty on carbon tax was applied, placing more emphasis on functional traits (10%). A quota scenario resulted in a similar response per animal as Scenario 1 (69.794€/year), with production traits accounting for the 96% of this total economic response, however a reduction in the number of animals per farm would be expected to accomplish with the quota, and therefore lower benefits.

Selection for cows with lower carbon footprint involves changes in the animal, while ensuring profitability in future generations. This study showed different strategies to tackle emissions through breeding. Any strategy to tackle methane emissions in beef cattle needs to be carefully considered because it will have an impact on the type of cows in future generations.

OBJETIVES

- Test foreseen strategies to include methane emissions in the breeding goal of beef cattle.
- Determine expected consequences in profitability, functional and production traits.

MATERIAL AND METHODS

Trait	MEAN (S.D)	N° RECORDS	N° HERDS	YEARS
Functional traits				
Age at first calving (months)	35.8 (5.3)	7.056	238	1983-2016
Calving ease (1-4)	1.13 (0.41)	29.481	138	1990-2016
Calving interval (day)	417.1 (83.9)	29.562	251	1983-2016
Cull cow carcass weight (kg)	465.9 (116.9)	1.401	70	2004-2016
Cull cow carcass classification (1-15)	7.69 (2.45)	1.401	70	2004-2016
Production traits				
Carcass weight (kg)	326.2 (56.0)	8.388	90	2004-2016
Carcass weight gain (kg/day)	0.893 (0.153)	8.388	90	2004-2016
Carcass classification (1-15)	9.59 (1.47)	8.407	90	2004-2016
Weaning weight (kg)	291.1 (55.2)	8.718	136	2000-2016
Birth weight (kg)	45.3 (2.9)	36.135	249	1995-2016
Other data				
Price of cows' supplementation (€/UFL)				0.12
Price of fattening calves' supplementation (€/UFC)				0.22
Shadow price (€/ CH4 kg)				1.01
Price per calves carcass kg (€/kg)				3.96

➔ METHANE EMISSIONS (IPCC. 2006)
Estimation of methane emissions from gross energy requirements

- ENTERIC FERMENTATION
- MANURE MANAGEMENT

➔ GENETIC PARAMETERS
Estimation of heritabilities and genetic correlations for:

- FUNCTIONAL TRAITS
- PRODUCTION TRAITS
- METHANE TRAITS

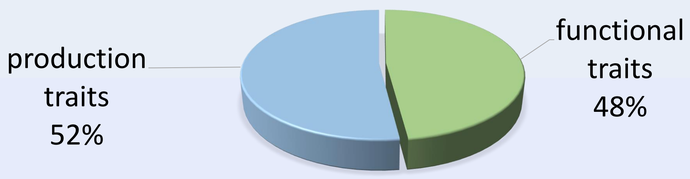
➔ ECONOMIC WEIGHTS AND SELECTION INDDICES
Development of bioeconomic model to estimate economic weights in different scenarios:

- SCENARIO 1: REPLACEMENT INDEX
- SCENARIO 2: CARBON TAX
- SCENARIO 3: CH_4 QUOTA BY FARM

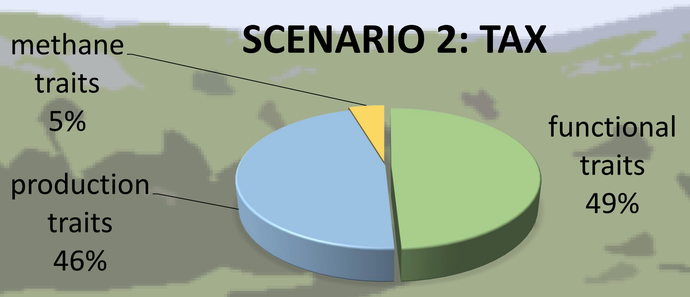
RESULTS

ECONOMIC WEIGHTS

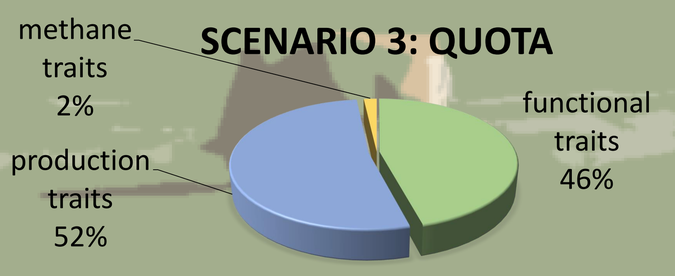
CURRENT SCENARIO



SCENARIO 2: TAX



SCENARIO 3: QUOTA



EXPECTED RESPONSE

TRAIT	Expected response					
	SCENARIO 1		SCENARIO 2		SCENARIO 3	
FUNCTIONAL TRAITS	UNIT OF TRAIT	€/yr	UNIT OF TRAIT	€/yr	UNIT OF TRAIT	€/yr
Mature weight (kg)	6.47	-3.23	2.71	-1.47	5.98	-2.81
Age at first calving (d)	-11.37	1.48	-12.63	1.82	-12.17	1.58
Calving interval (d)	-2.74	3.80	-2.87	4.29	-2.78	3.64
Maternal calving ease (1-4)	0.00	-0.02	0.00	-0.07	0.00	-0.03
Maternal weaning weight (1-4)	-3.93	-0.79	-3.51	-0.77	-4.14	-0.50
Culled cow carcass conformation score (1-16)	0.13	0.40	1.88	0.40	0.13	0.40
Culled cow carcass weight (kg)	4.49	0.63	0.13	0.21	4.15	0.46
PRODUCTION TRAITS						
Calving ease (1-4)	0.03	-0.36	0.04	-0.62	0.02	-0.32
Weaning weight (kg)	4.05	0.81	3.04	0.67	3.73	0.45
Carcass conformation score (1-16)	75.40	58.81	0.39	7.55	75.07	60.21
Carcass weight gain (g/dy)	0.39	7.54	72.82	54.61	0.39	7.48
METHANE TRAITS						
CH_4 Kg calves in fattening (CH_4 kg/yr)	-0.64	0.00	2.61	-1.36	-0.77	0.12
CH_4 Kg cows (CH_4 kg/yr)	2.90	0.00	-0.75	0.17	2.79	-0.95
BENEFIT (€/yr)		69.1		65.4		69.7

CONCLUSSIONS

- Whether CH_4 emissions are included in the breeding goal and how this is implemented affect the future type of cow for beef production.
- A carbon tax will impose breeding for smaller cows with better maternal abilities.
- Establishing a CH_4 quota per farm will make more emphasis on calf traits, mainly carcass weight gain, while slightly reducing maternal size, the maintenance of CH_4 emissions is obtained at expenses of reducing the number of animals per farm.
- Future policies that aim reducing GHG emissions from livestock must carefully consider the consequences for the future generations of cattle and producers.