



Prediction of the various beef quality traits

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► To cite this version:

Jean-François J.-F. Hocquette, Raphaëlle Botreau, I. Legrand, R. J. Polkinghorne, David Pethick, et al.. Prediction of the various beef quality traits. International Conference summarizing the implementation of ProOptiBeef Project, May 2015, Varsovie, Poland. hal-02801516

HAL Id: hal-02801516

<https://hal.inrae.fr/hal-02801516>

Submitted on 5 Jun 2020

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Prediction of the various beef quality traits

(adapted from Animal Production Science, 2014, 54, 1537–1548, Joint ISNH / ISRP International Conference 2014)



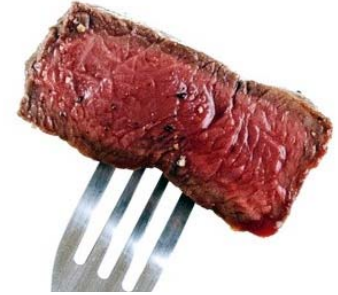
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The definition of quality



***Intrinsic* quality refers to the characteristics of the product** itself and includes **sensory traits** (e.g. tenderness, flavor, juiciness, overall liking), **safety**, **healthiness**, **convenience**, etc.

***Extrinsic* quality refers to traits which are associated with the product**, namely (i) **production system characteristics** (from the animal to the processing stages including for example animal welfare and carbon footprint), and (ii) **marketing variables** (including price, brand name, distribution, origin, packaging, labelling, and traceability)

Outline

1. Recent progress to predict beef quality

1.1. Grading systems

1.2. Recent progress in biochemistry and genomics

2. Win–win strategies or trade-offs for extrinsic and intrinsic quality traits of beef

2.1. Win–win strategies for sensory quality and welfare issues

2.2. Win–win strategies and trade-offs between environmental value and other beef quality traits

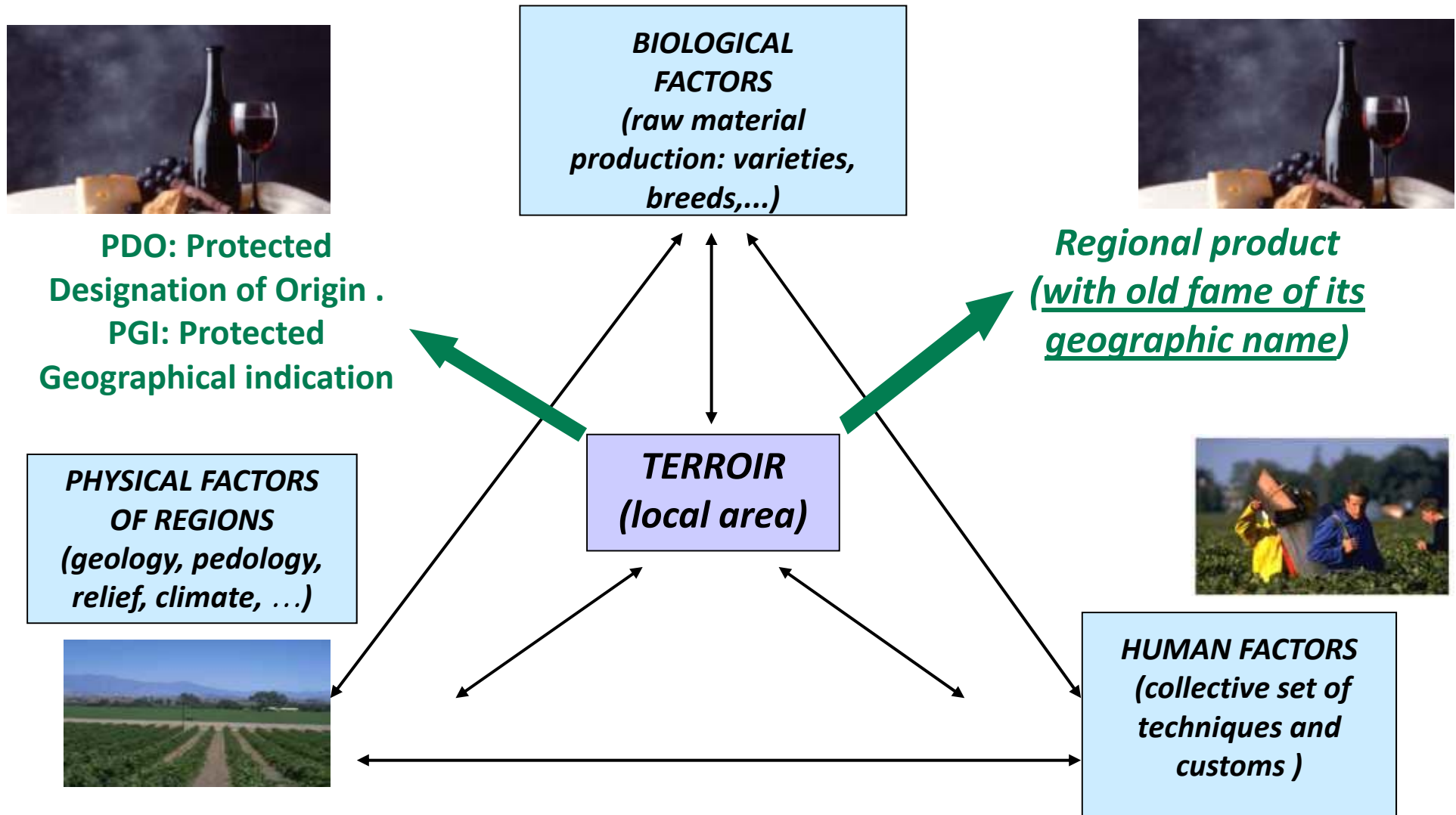
3. Future research priorities

Different beef grading schemes



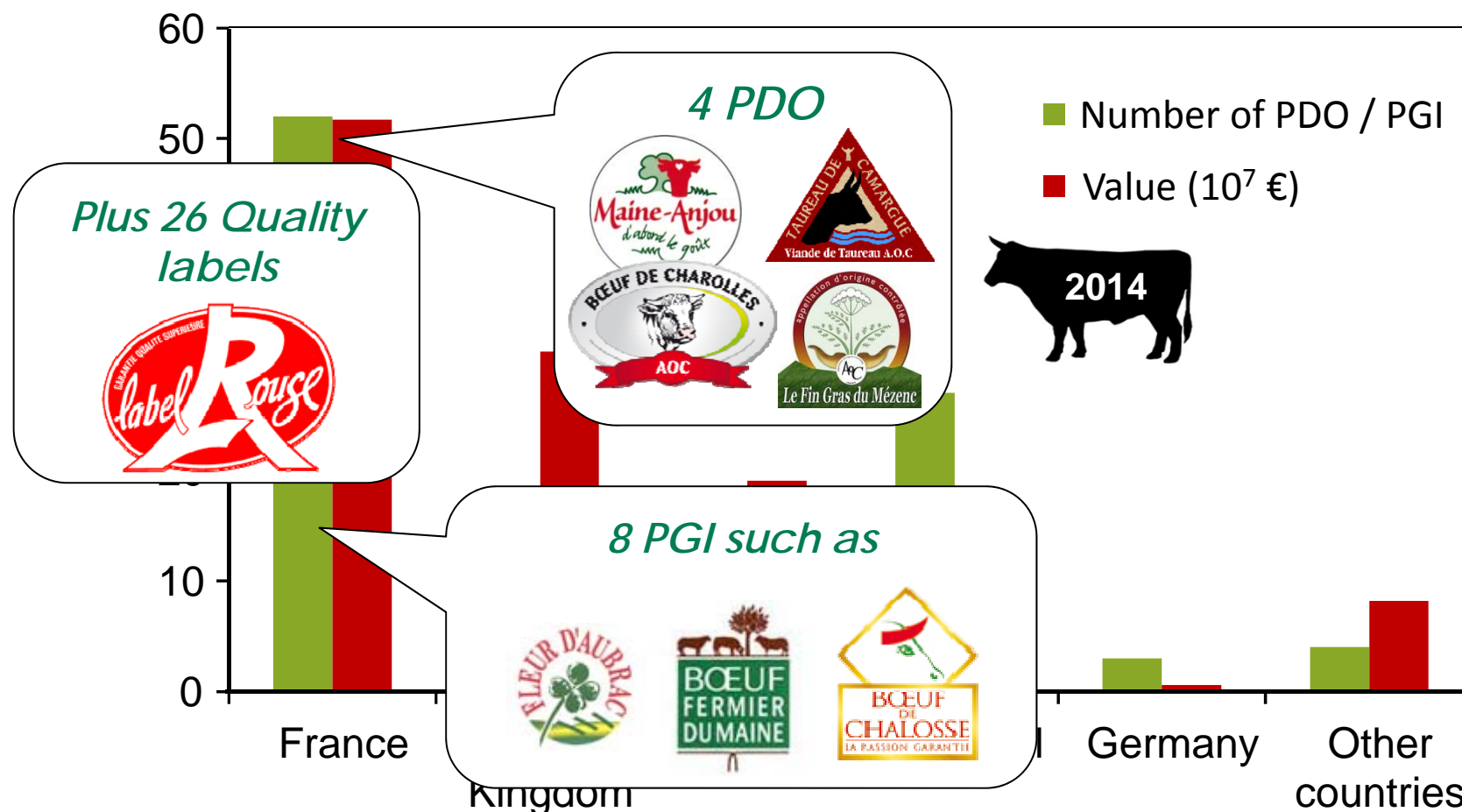
Country Scheme	Europe <i>EUROP</i>	S. Africa <i>S. Africa</i>	Canada <i>Canada</i>	Japan <i>JMGA</i>	S. Korea <i>Korea</i>	USA <i>USDA</i>	Australia <i>MSA</i>
Grading unit	Carcass						Cut
Pre slaughter factors							HGP implants & Bos Indicus
Slaughter-floor	Carcass weight and sex						Electrical stimulation Hang
Chiller	Conformation	Dentition	Conformation	Marbling score			
	Fat cover	Ribfat		Meat Colour			
				Fat colour and fat thickness		Ossification score	
				Eye muscle area		Fat thickness	
			Texture	Meat brightness	Texture	Meat texture	Hump height
				Fat luster	Firmness	Ribfat	Ultimate pH
				Fat texture	Lean maturity	Kidney fat	
				Fat firmness		Perirenal fat	
			Rib thickness				
Post chiller							Ageing time Cooking method

The concepts of designation of origin and geographical indication



Numbers and values of PDO/PGI fresh meat products (all species) in European countries

In 2008, a total of 106 PDO and PGI in Europe for a value of **1 billion €**



Prediction of beef quality using the MSA system

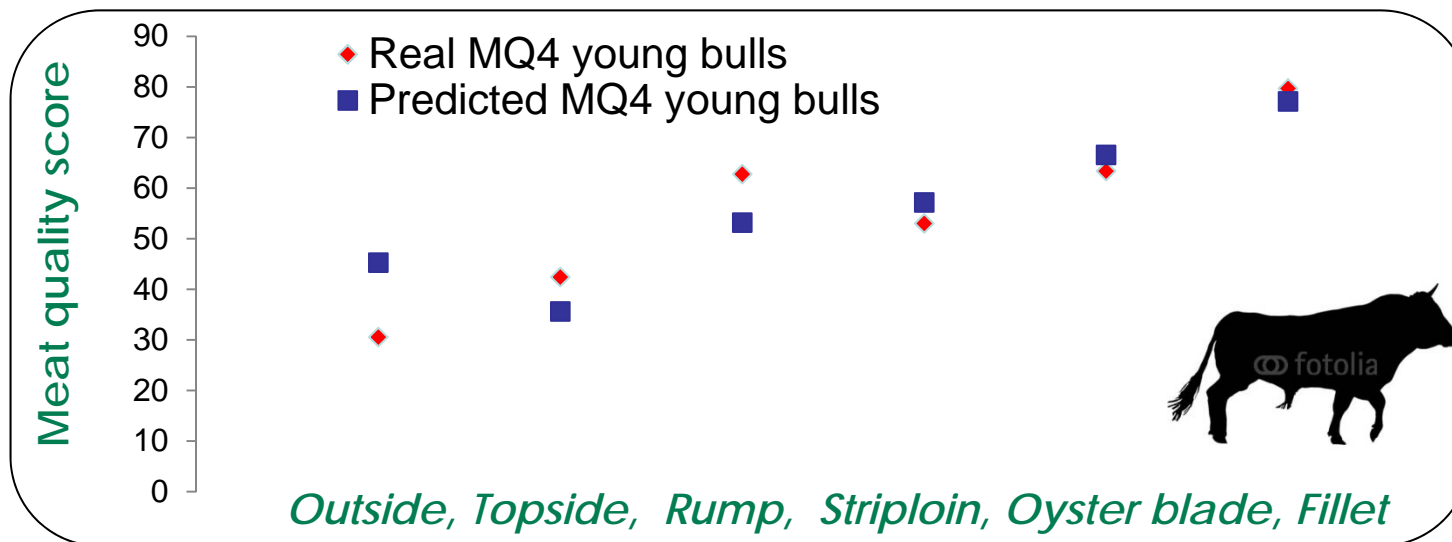
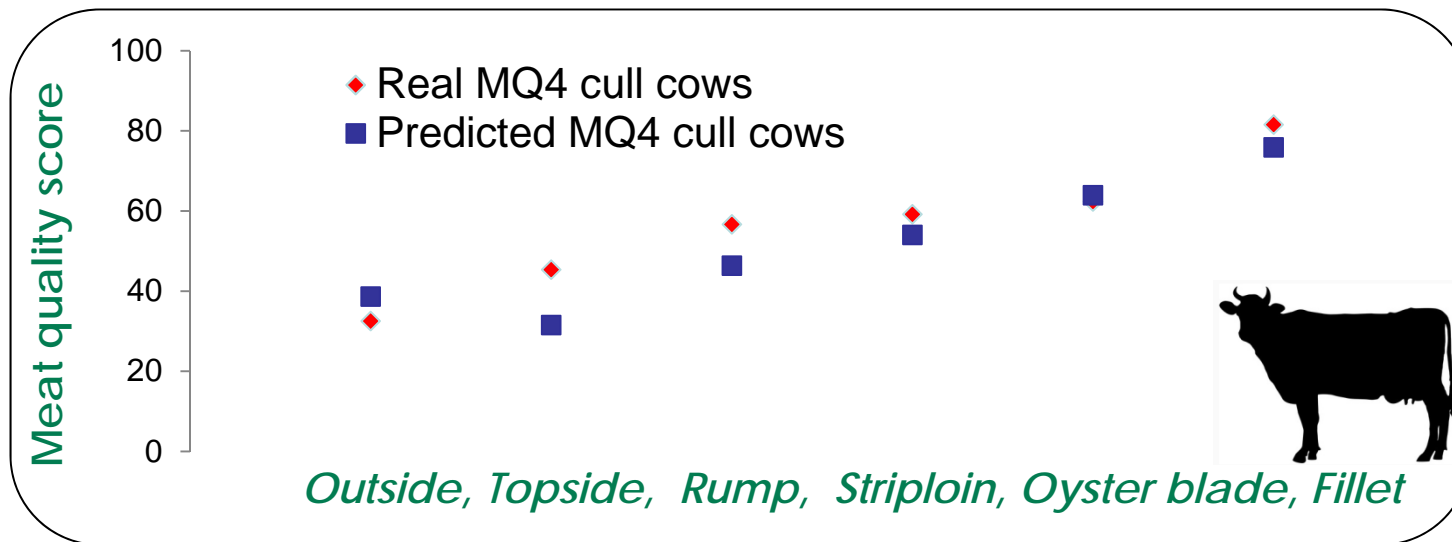
MSA2000model®

Hang (AT/TC/TS/TX)	AT
Sex (M, F)	m
Est.% Bos Indicus	0
Hump Height cms	0
Hot Std Carc Weight	250
USDA Ossification	140
Milk Fed Vealer Y/N	n
USDA Marbling	130
Days Aged (min 5)	5
Quarter Point Ribfat	12
Ultimate pH	5.50
AUSMEAT Meat Col.	2
Saleyard? (Y, N)	n
Wght/App.Maturity	0.86

Cut Description	Muscle Reference	Days Aged	Grilled Steak	Roast Beef	Stir Fry	Thin Slice	Cass-erole	Corne d Beef
Tenderloin	TDR062		5	4	5			
Cube Roll	CUB045		3	3	3			
Striploin	STR045		3	3				
Oyster Blade	OYS036		4	3				
Bolar Blade	BLD096		3	3				
Chuck Tender	CTR085			3	3			
Rump	RMP131		3	3	3	3		
Point End Rump	RMP231		3	3	3	4		
Knuckle	KNU099		x	3	3	3	3	
Outside Flat	OUT005			x	x	3	3	3
Eye Round	EYE075		x	3	3	3	3	x
Topside	TOP073		x	x	x	3	3	
Chuck	CHK078			3	3	3	3	
Thin Flank	TFL051				3		3	
Rib Blade	RIB041				3			
Brisket	BRI056				x	3	3	x
Shin	FQshin						3	

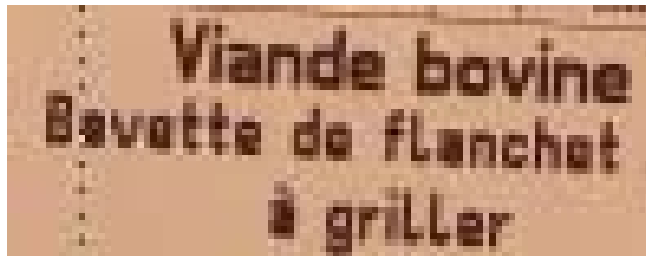
Palatability grade

Prediction of quality in France using the MSA system



A new denomination of beef cuts in France

Before, on the label



Beef meat
Name of the cut
How to cook it

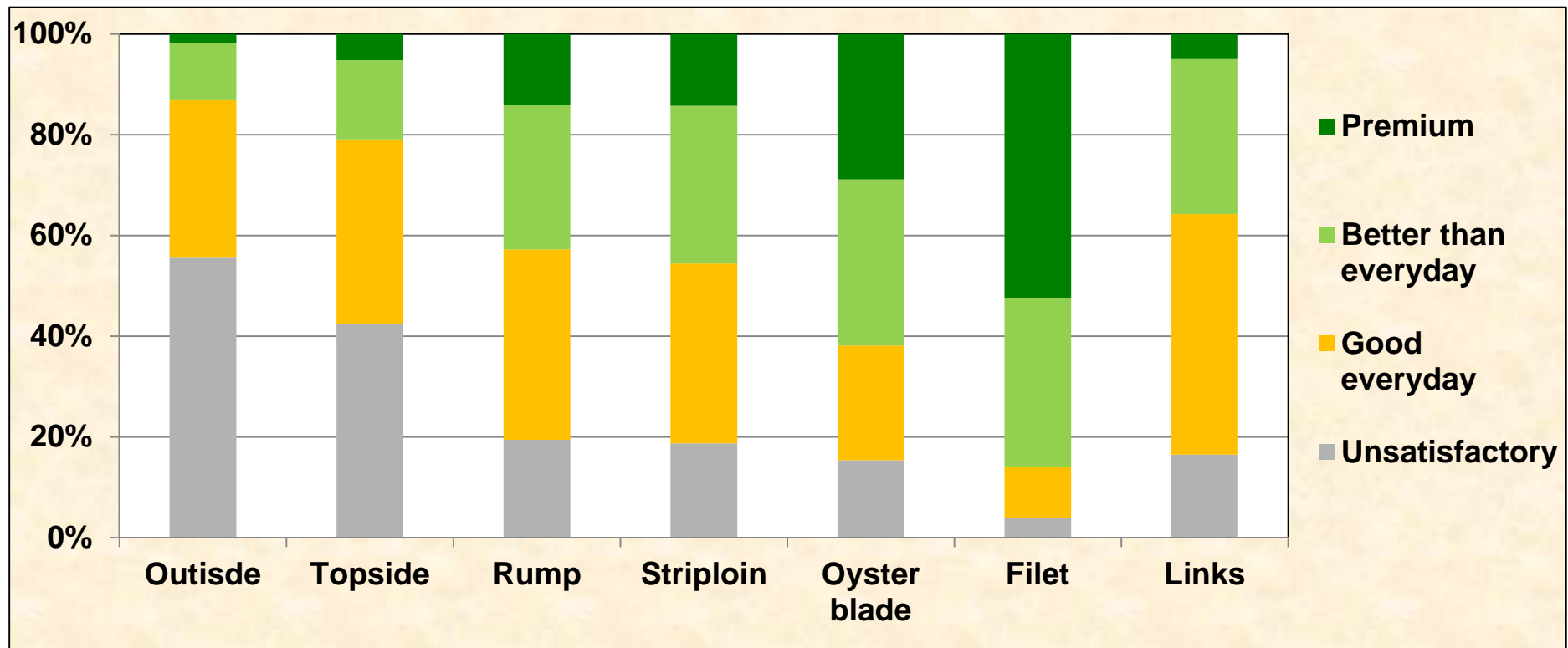
Last December

- Cut (if already known) or group of cuts (for cuts not well known)
- Quality level indicated by stars
- How to cook it

Instead of buying
« poire » (a cut part of topside not very well known),
the consumer will buy
« steak *** to grill »

Prediction of quality in France using the MSA system

- Considerable variability for each muscle
- But visible muscle hierarchy (Link = Striploin & rump)



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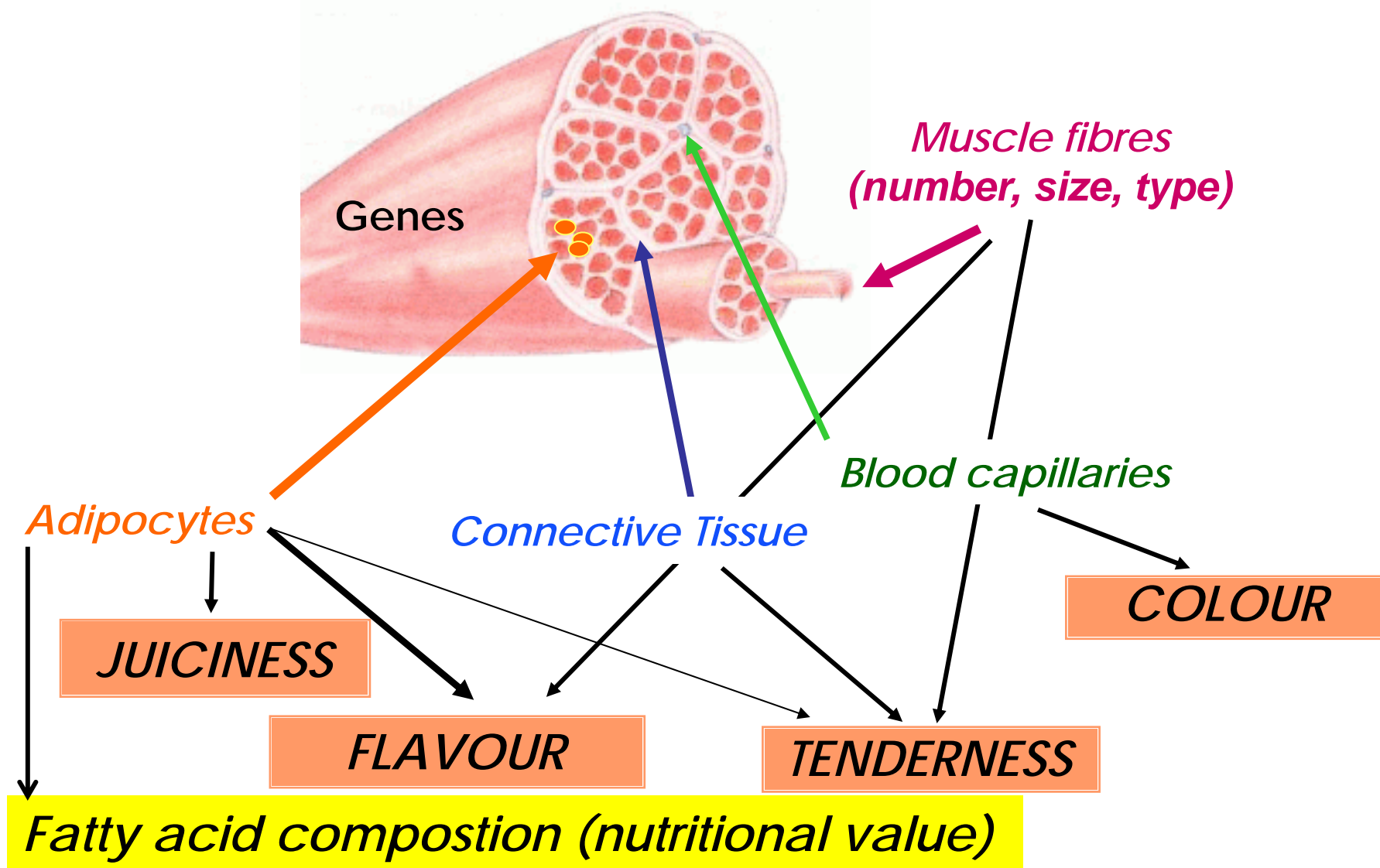
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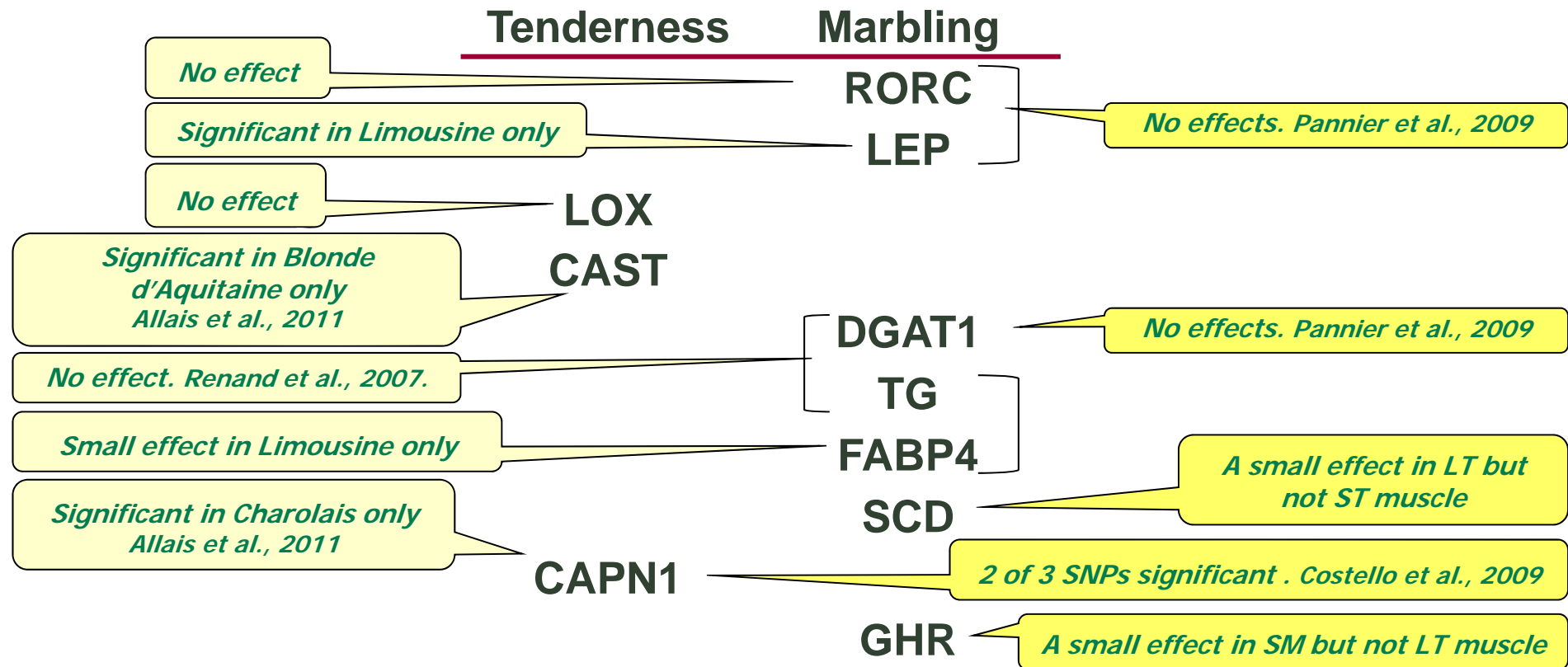
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How muscle biochemistry affects beef quality

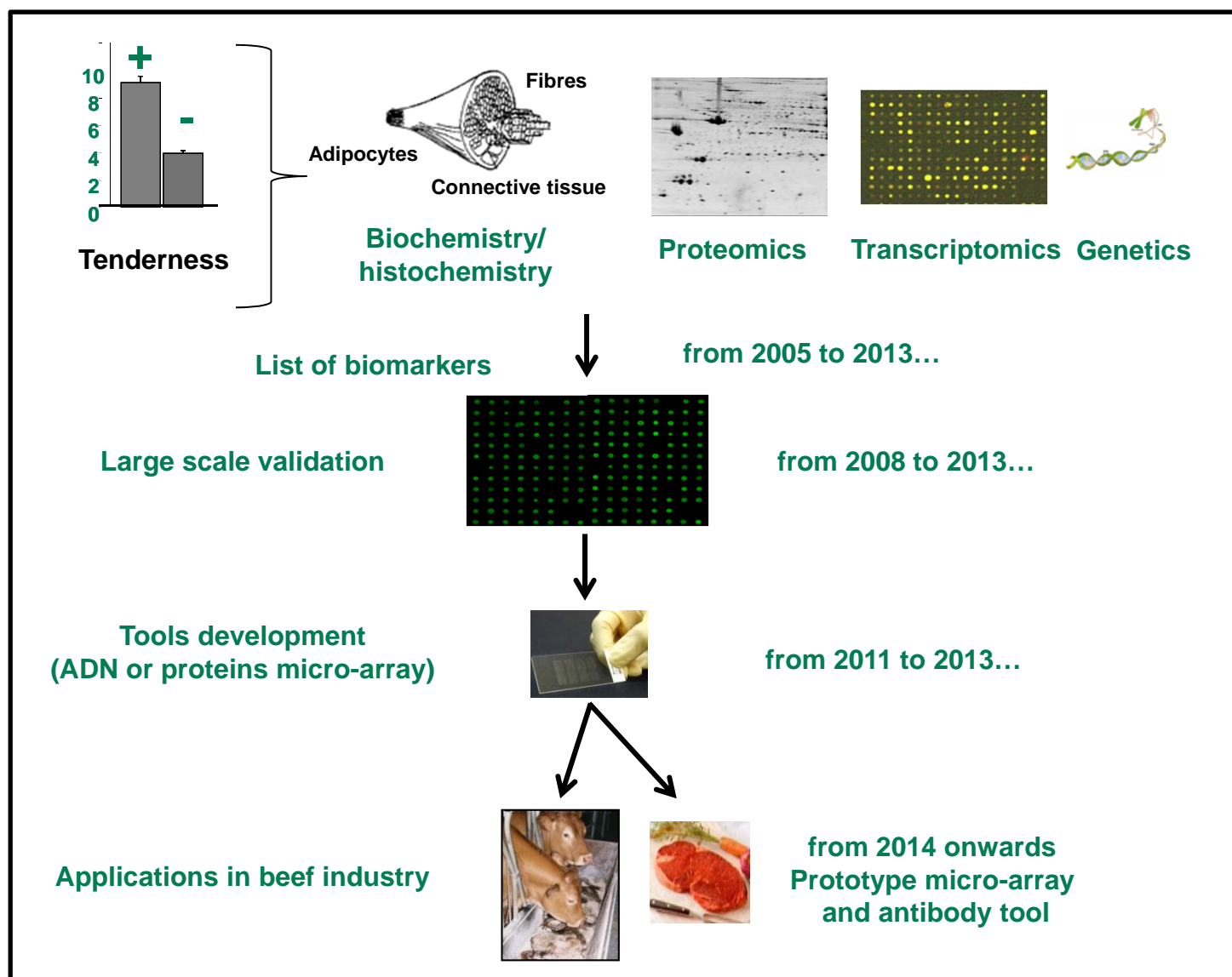


Relationships between genetic markers and Meat Quality attributes



The effects of the markers studied are variable, breed specific and muscle-specific (French and Irish results)

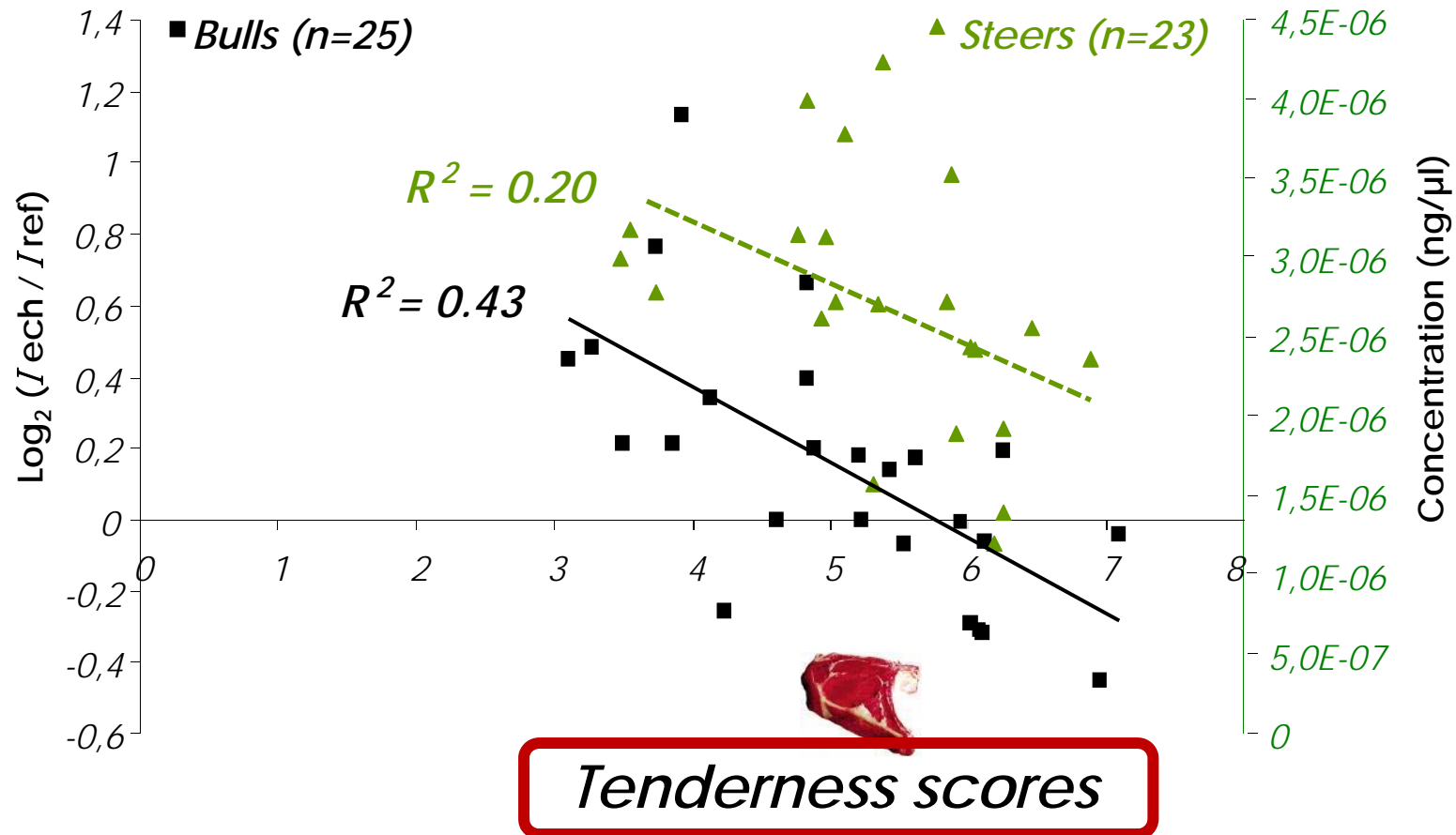
The overall strategy in functional genomics



DNAJA1: A negative marker for tenderness (patented)

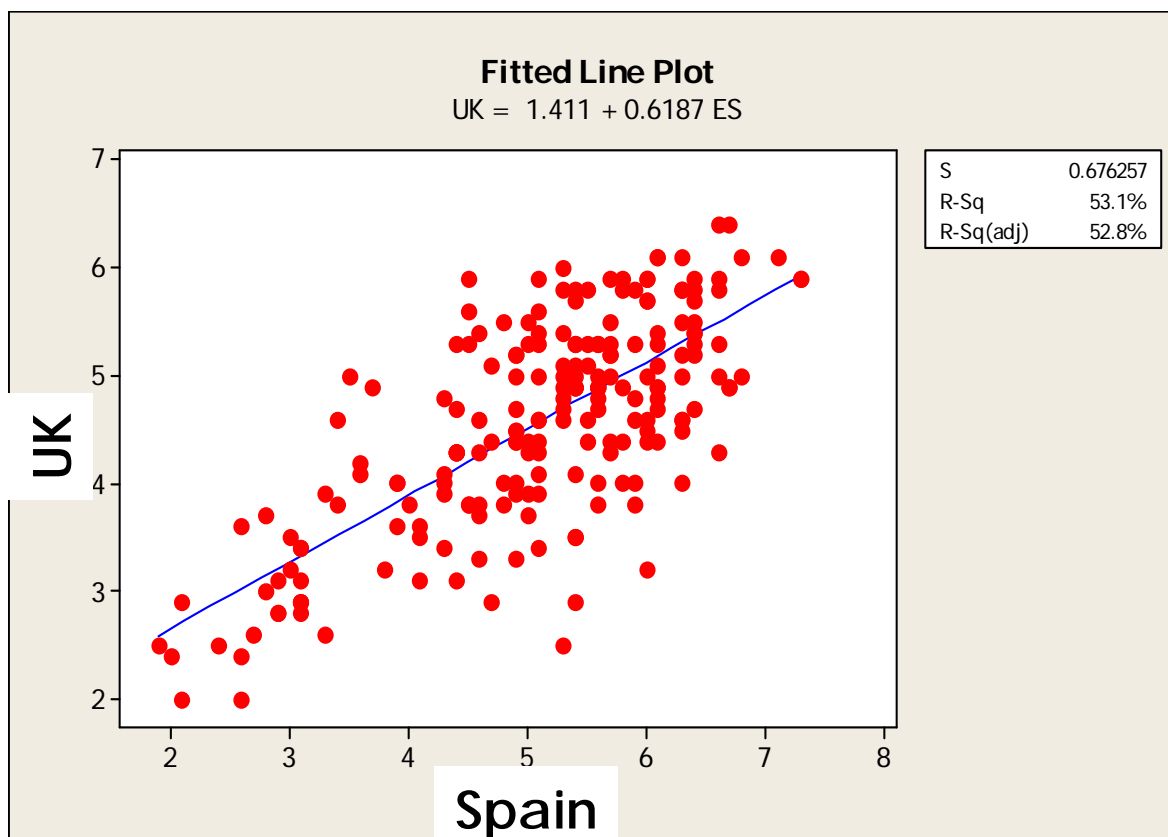
Expression level of
DNAJA1 with DNA chips

Expression level of
DNAJA1 by RT-PCR



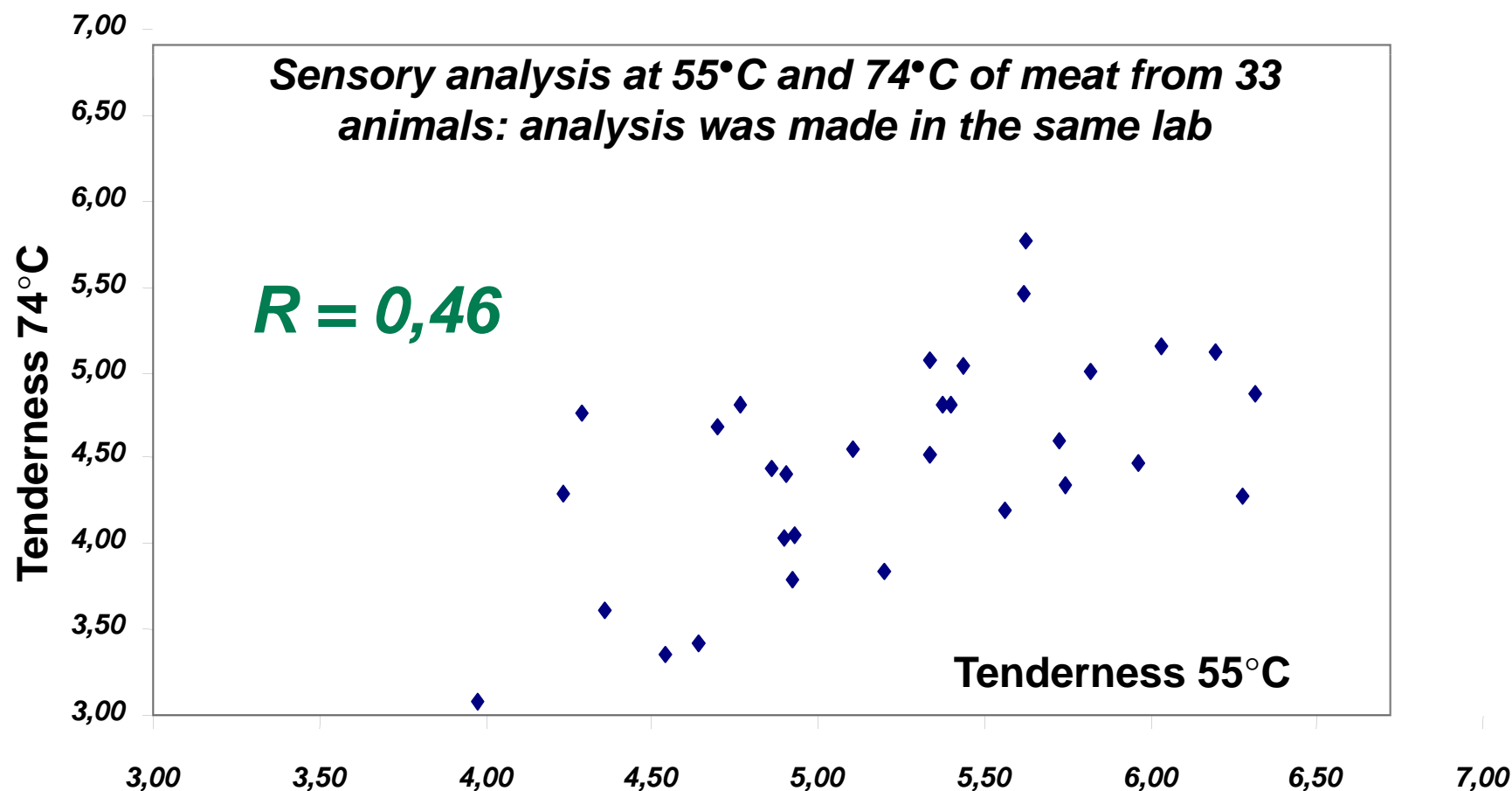
Sensory analysis in the GEMQUAL EU Programme (Genetics of Meat Quality)

✓ *Comparison of the same samples between Spain and UK*



Measurement of tenderness is more or less repeatable across countries

Tenderness scores at 55°C and 74°C



Measurement of tenderness is not very repeatable across temperatures

Challenges

- Genotyping is performed in a standardized and automated way using robots.

→ It should be the same for phenotyping

- For traits with low measurement repeatability ($r < 0.95$), 2 or 3 independent measurements of the same trait should be obtained on the same samples.
- Individuals should be genotyped solely for strongly correlated traits for independent measurements (*Barendse 2011*).

→ In a few words: standardization, automation, high repeatability.

- ‘In the age of the genotype, phenotype is king’ (*Coffey 2011, ICAR Meeting*).

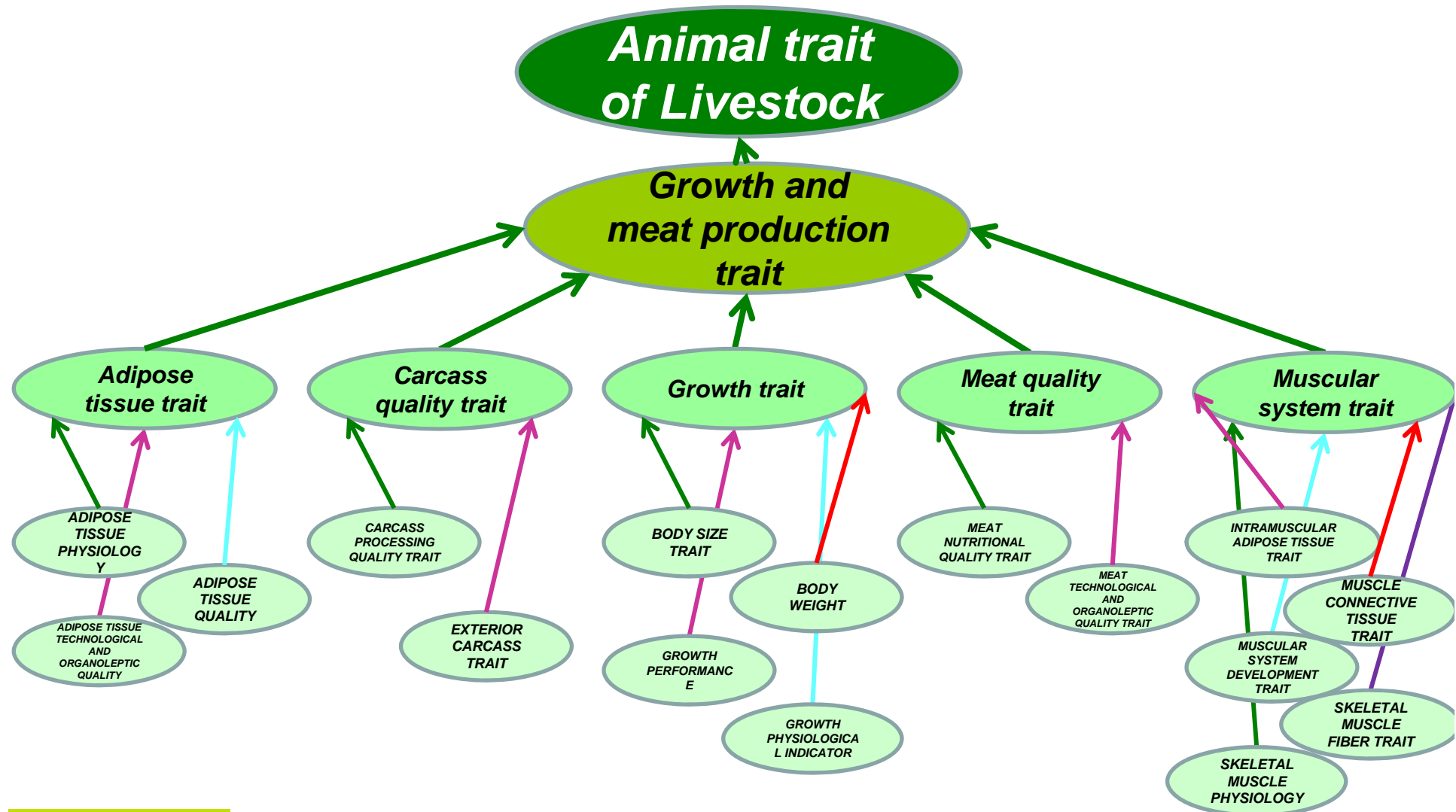
ATOL (Animal Trait Ontology of Livestock)

The objectives

1. To have **a reference ontology** for phenotyping of farm animals shared by international scientific and teaching community.
2. To have a **language usable by** software (data basis management, semantic analysis, modeling...)
3. To have the traits as **generic** as possible
4. To have the ontology as **efficient** as possible and close to technical measurements
5. To have a structure applied to **production** targets



Hierarchy for growth and meat production trait



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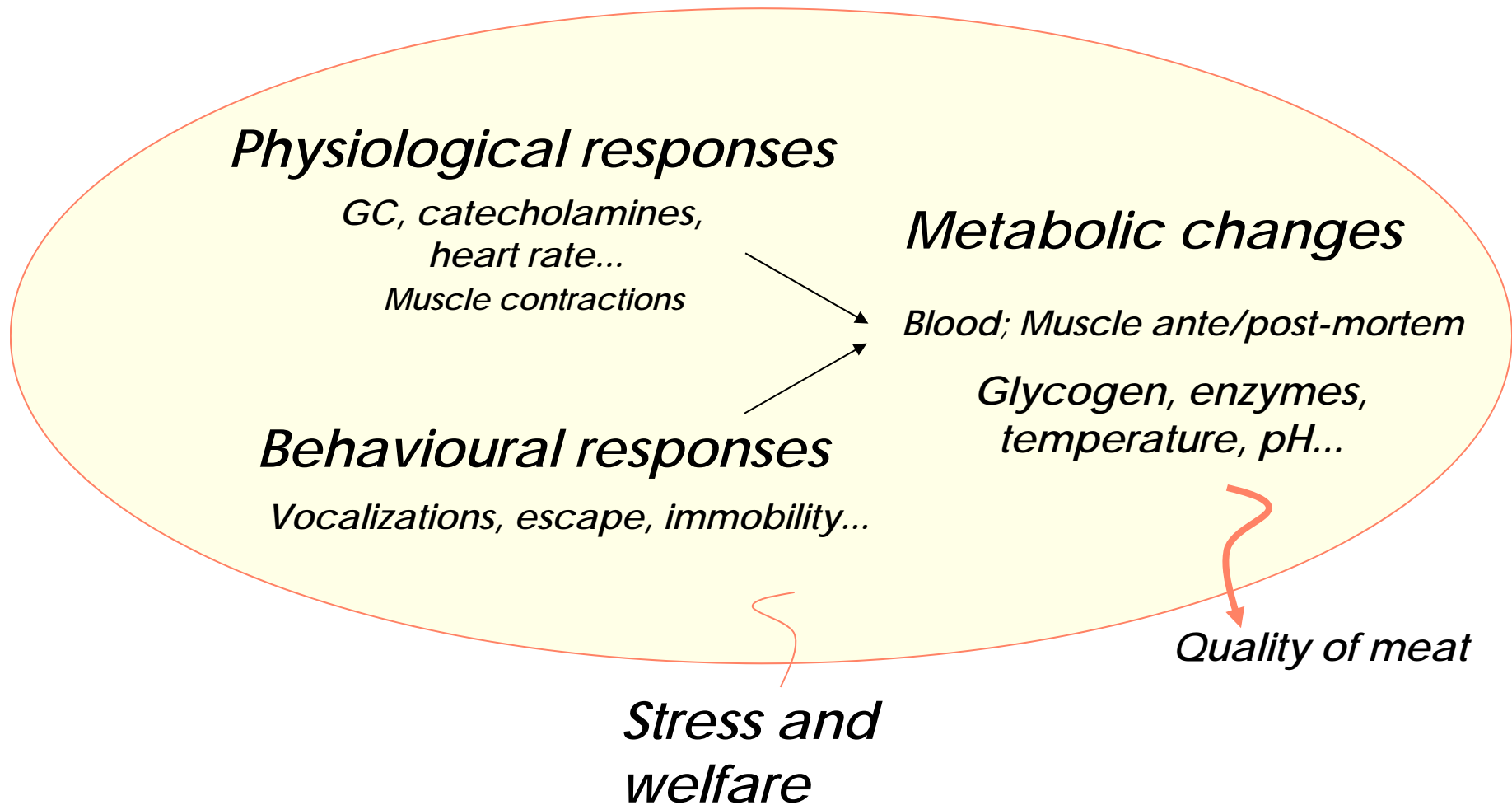
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3. Future research priorities

Slaughter: Stress and welfare – A lot of measurements

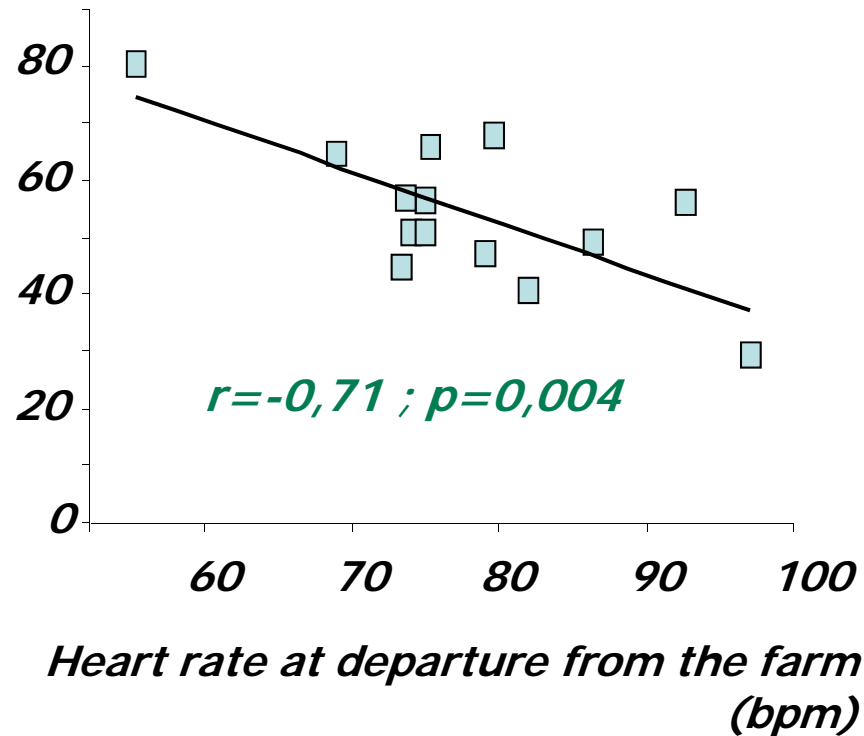


Stress at slaughter and beef quality



⇒ 14 cows (Normand breed)

Tenderness
score



Win-win relationship:

Cows

- with the lowest stress

low heart rate before slaughtering

- provide the most tender beef

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Environmental impacts of three contrasting diets

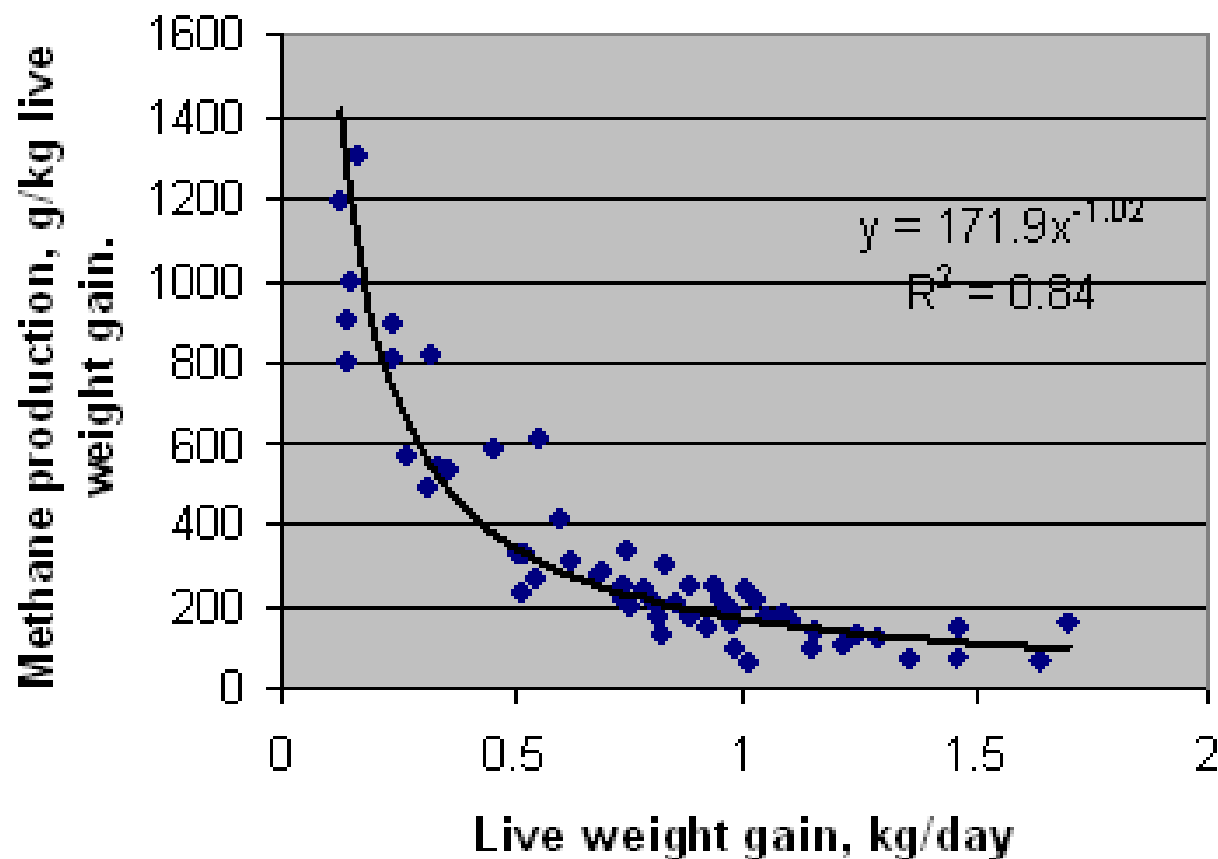
⇒ *Blond d'Aquitaine young bulls*



	% concentrate → % forages →	35% 65% corn silage	50% 50% hay	86% 14% wheat straw
		Per kg of body weight gain		
greenhouse gas (GHG) emissions in kg eq-CO ₂ <i>Including enteric methane</i>		4.74 2.23	4.56 2.23	☺ 3.75 0.84
Energy consumption eq-MJ		☺ 13.0	18.7	19.8
Eutrophication potential g eq-PO ₄ ³⁻		18.6	☺ 15.8	20.8

Each diet has different advantages and disadvantages

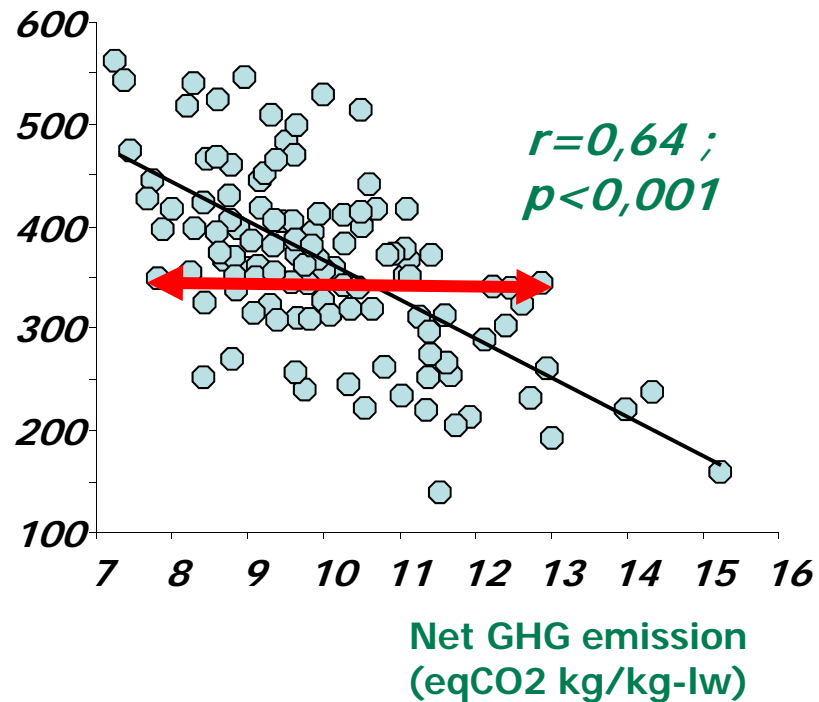
The relationship between live weight gain and methane production per kg of gain



The most efficient animals produce the least methane

Win-win strategies between environmental value and economic efficiency

Bovine gross margin
("€/UGBb" = €/LU)



High variability :

- from 7 to 15 for GHG emissions
- from 150 to 550 for gross margin



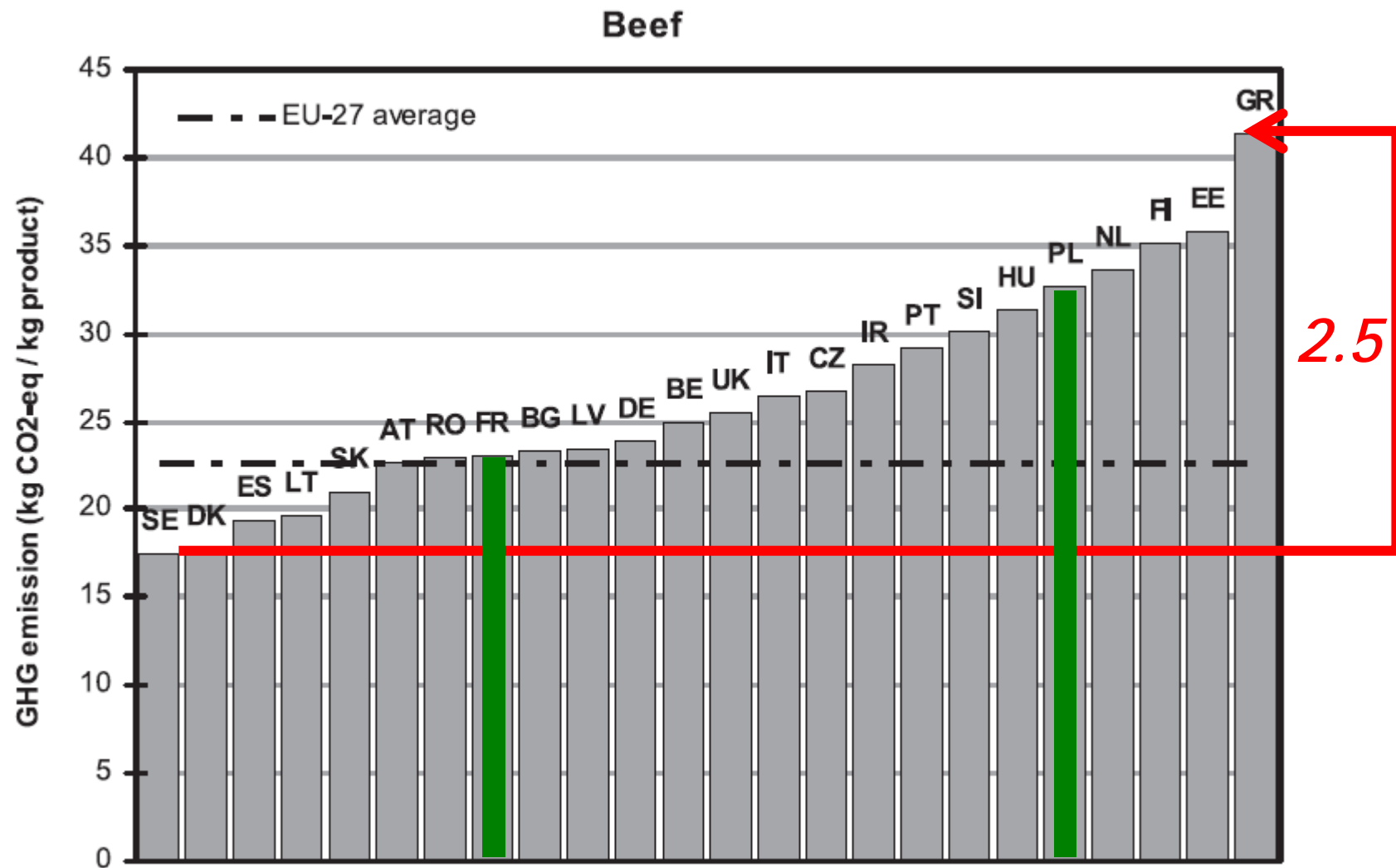
59 farms in the Charolais area from 2010 to 2011.

Win-win relationships:

Farms

- the most efficient on an economic basis
- are also the most efficient in terms of GHG emissions

GHG emissions/kg of beef for EU member states



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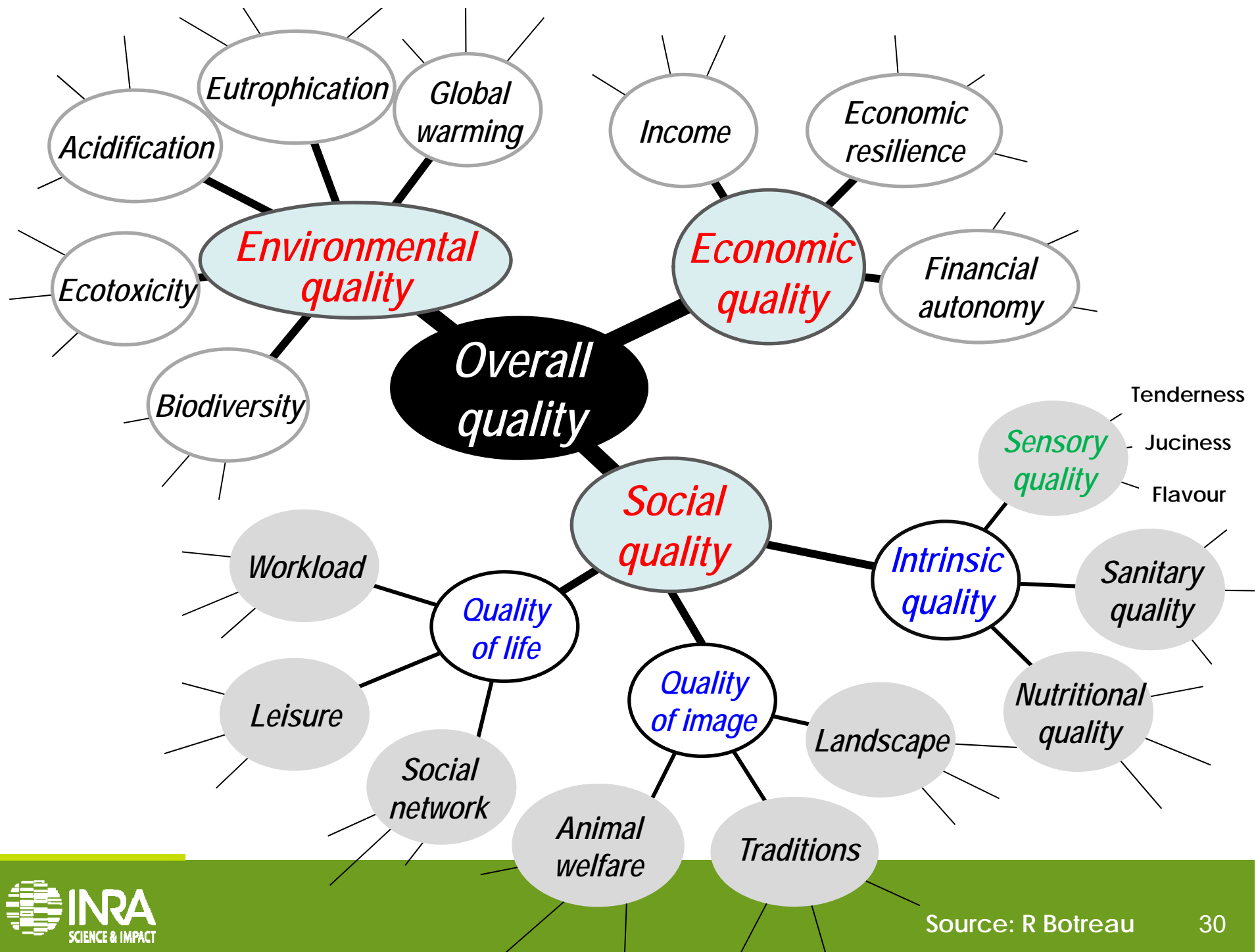
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Need to combine different criteria of quality. But how?

1. **Analysis by an expert:** done by traditional butchers. Not transparent, not exhaustive and also not consistent across experts.
2. **Minimum requirements (= thresholds)**
easy to understand and implement but rough evaluation (good vs bad).
3. **A ranking system** from best (rank 1) to worst (rank n), and a summation of the ranks: this is only a 'relative' judgment, comparing alternatives among themselves, and not an 'absolute' assessment.
4. **Conversion of quality traits into value-scores**
(e.g. quantitative information on a common scale) which are then compounded (e.g. the MSA system for sensory analysis based on a weighted sum, difficult to do).

Etc.

Potential of grazed based systems

Beautiful landscape

Happy cows

PUFA-rich meat

Biodiversity

Natural feeding

Carbon sequestration

Conclusions about multicriteria approaches

- ✓ **Consumer satisfaction** when eating beef involves a complex response based on **objective** and **emotional** assessments of the product.
- ✓ **Scientific research** must provide **methods** to predict, in a reliable manner *intrinsic* quality traits of beef (as MSA does).
- ✓ **Scientific research** must also provide **methods** to predict, in a reliable manner *extrinsic* quality traits of beef.
- ✓ **Combining *intrinsic* and *extrinsic*** quality traits by relevant and new methods is a key driver for the future.