



THE BEEF SECTOR IN ITALY: PRODUCTION, CONSUMPTION AND QUALITY

**A Workshop for the Students of the International Master
“Global Quality in European Livestock Production”**

DISAFA, Grugliasco (Torino) - VetAgro-Sup, Clermont-Ferrand

Grugliasco, 10-11 febbraio 2020

Prof. Alberto Brugiapaglia

SUMMARY

- **BEEF SECTOR IN ITALY**
- **BEEF CONSUMPTION IN ITALY**
- **WHAT IS MEAT?**
- **WHAT IS QUALITY?**
- **WHAT IS MEAT QUALITY?**
- **EXPERIMENTAL RESULTS**

THE BEEF SECTOR IN ITALY

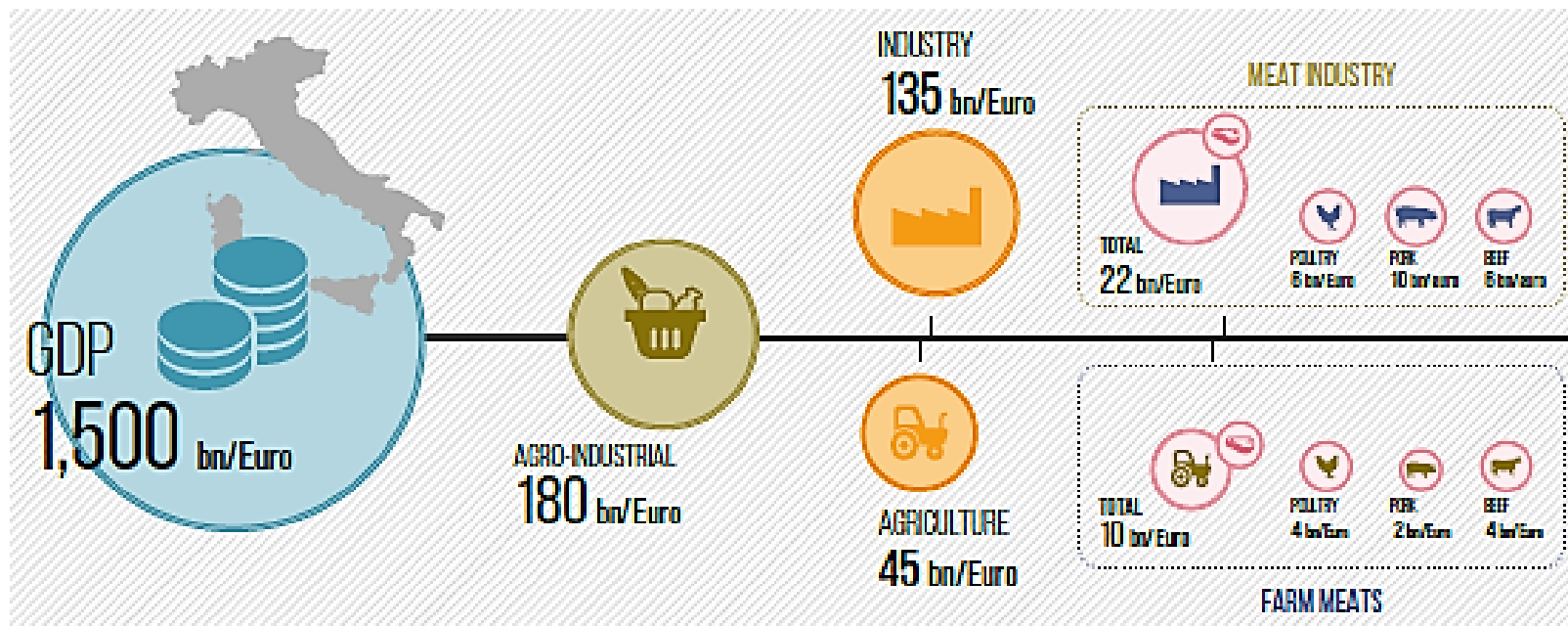


The beef sector in Italy

The agriculture and food sector in Italy accounts for about 10-15% of the annual Gross Domestic Product, with a total value of approximately 180 billion Euro.

Of these, about 30 are derived from the **meat sector**, including both the agricultural and industrial production.

The three main sectors (beef, poultry and pork) generate a turnover of around 20 billion Euro per year, resulting mainly from the processing industry.



The beef sector in Italy

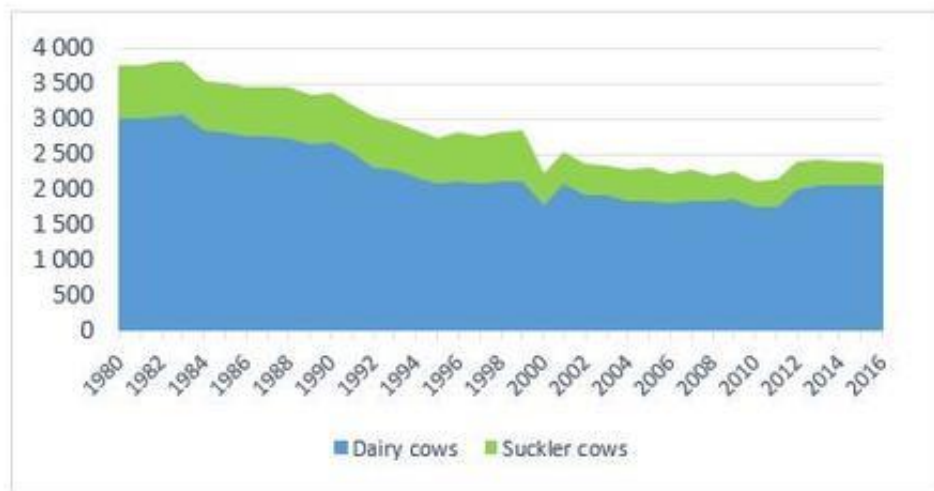
With 6.3 million heads, Italy currently has the 5th largest **cattle herd** in the EU, with the 4th **dairy herd** and the 7th **suckling herd**.

The cattle herd has remained relatively stable since 2000, fluctuating between 6 and 7 million heads but has declined by 29% compared to the 1980s.

It is due to a significant drop by 43% of the **suckling herd** between the 1990s and today, and a decline by 30% of the **dairy herd** between 1980 and 1995.

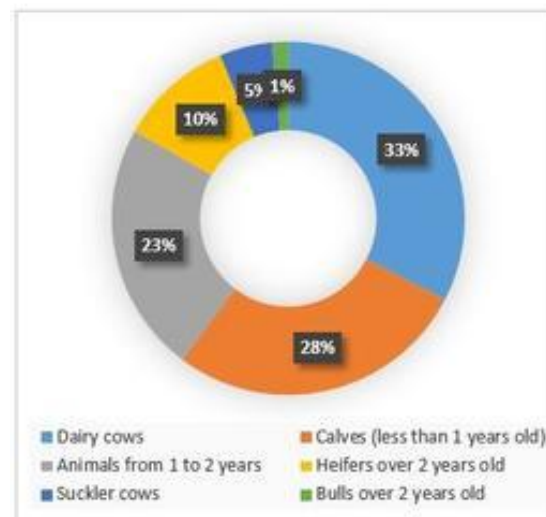
In 2016, the Italian cattle herd was composed mainly by **dairy cows** (33%) and **young animals** (under 2 years old).

Figure 16 : Evolution of the Italian cattle herd (x1000 heads)



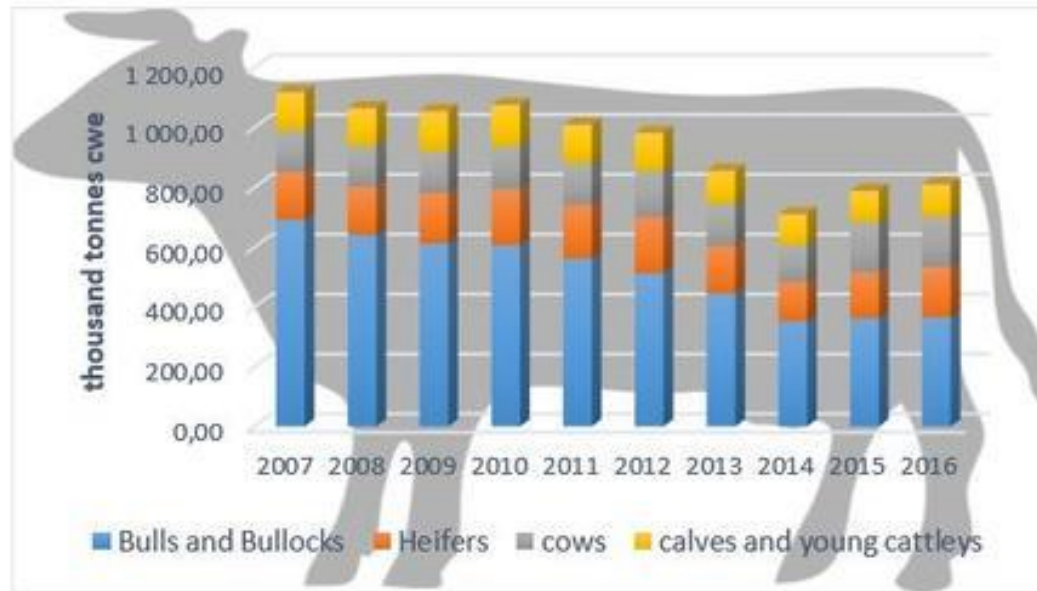
Source : Inra, by Eurostat

Figure 17 : Type of animals held in farms in Italy in 2016



Source : Inra, d'après Eurostat

Figure 10 : Evolution of Italian beef production



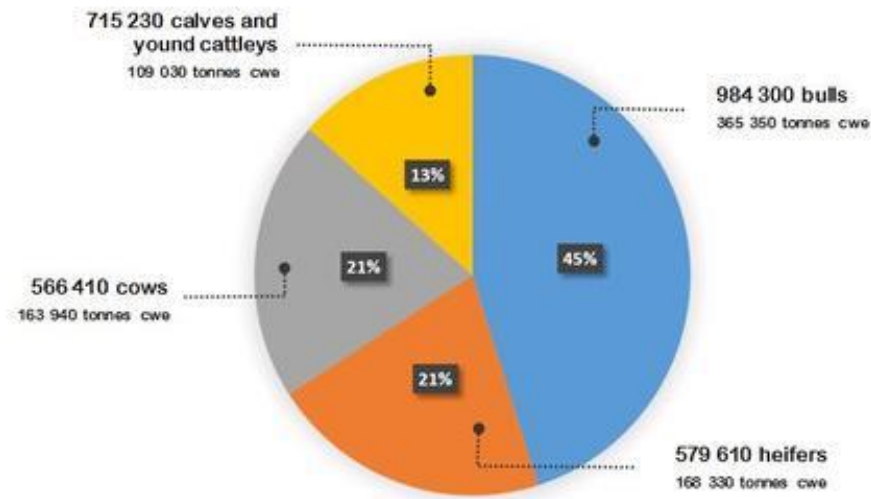
Source : Inra, by Eurostat

Beef represents 50% of the meat tonnage consumed in the country.

As the 4th largest beef producer in Europe, Italy produced **809.600 T (Carcass Weight Equivalent)** in 2016 (from 2.85 million heads), accounting for 10.4% of the EU production.

About 40% of its slaughtered animals came from import of lean cattle, fattened in Italy.

Figure 11 : Type of bovine animal produced in Italy in 2016



Source : Inra, by Eurostat

Italian consumers have a preference for **tender and light colored meat** corresponding to a production of **young cattle** (male and female) slaughtered between 16 and 22 months old, called **“vitelloni”**, and accounting for 66% of the Italian production in 2016.

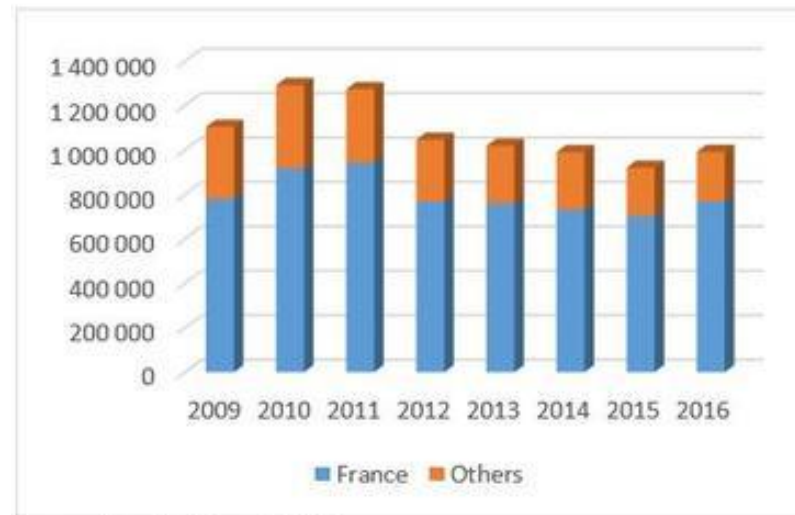
Culled cows accounts for 21% of the beef produced and **veal** for 13%.

Italian reproductive herd is for 87% a dairy herd, that's why cows slaughtered in Italy are mainly culled dairy cows. Heifers for dairy cattle are intended to restock cow herd.

Half of the **male calves from dairy herds produced veal**, the remaining can be crossed breed and fattened to produce young bulls.

However, **54% of young bulls slaughtered in Italy were from specialized suckling breeds, including imported animals.**

Figure 12 : Evolution of live cattle Italian imports (excluding animals for breeding) (number of heads)



Source : Inra, by FranceAgriMer

To satisfy its need of young animal for its market, **Italy imports live cattle** (“broutards”) to be fattened mainly in northern Italy.

With almost 992.000 heads imported in 2016, **Italy is the largest cattle importer in EU.**

France is Italy’s main supplier of cattle for **fattening** and for **slaughter** with respectively 77.6% and 73.3% of the market share in 2016.

Austria, the second supplier only accounts for 6% of Italian live imports.

Beef production systems

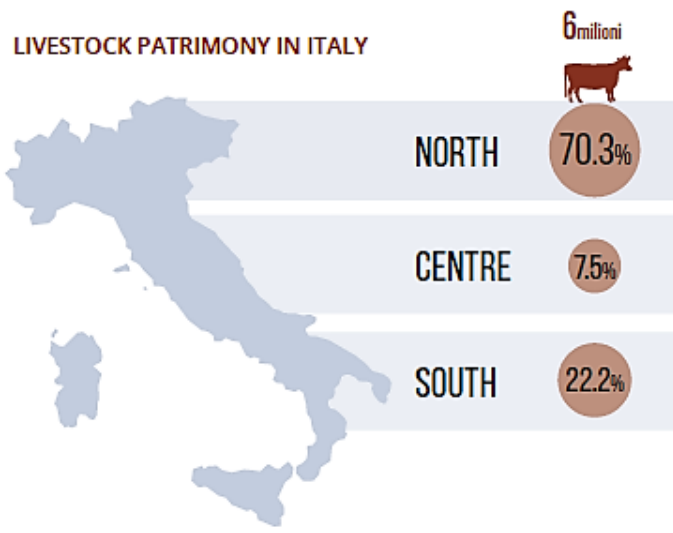
France

- Suckler cows 50% of the cow herd;
- Mainly located in the North and the Centre of the country;
- Main feed is maize silage plus grains and concentrates;
- Silage is the only production system for bulls. Great variety of beef breeds, among them Charolais and Limousin.

Italy

- Suckler cows 15% of cow herd;
- Specialized beef finishing farms in the North of Italy relatively large-sized,
- Mostly home grown maize silages plus concentrates and grains;
- Young bulls and heifers main category;
- Charolais, Limousine and French crosses (imported from France);
- Local beef breed (Piemontese, Chianina) destined to niche market.





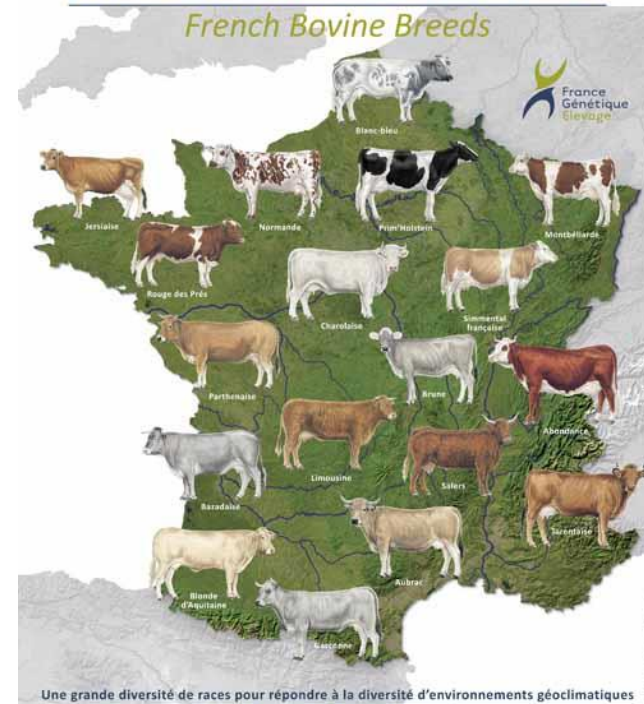
About 97% of the animals imported from France are reared in North Italy
 From 2016 to 2019, total cattle imported in Italy from France decreased (14%)

Live cattle imported in Italy from France

| | 2016 | 2017 | 2018 | 2019 | 2016/2019 N | 2016/2019 % |
|-------------------|---------|---------|---------|---------|----------------|----------------|
| All Regions | 927.347 | 971.145 | 948.081 | 797.308 | -130.039 | -14,02% |
| 1) Piemonte | 196.362 | 203.875 | 191.632 | 163.961 | -32.401 | -16,50% |
| 2) Lombardia | 196.362 | 203.875 | 191.632 | 163.961 | -32.401 | -16,50% |
| 3) Veneto | 440.152 | 474.606 | 481.381 | 410.575 | -29.577 | -6,72% |
| 4) Emilia Romagna | 53.057 | 59.912 | 57.380 | 45.301 | -7.756 | -14,62% |

RACES BOVINES FRANCAISES

French Bovine Breeds



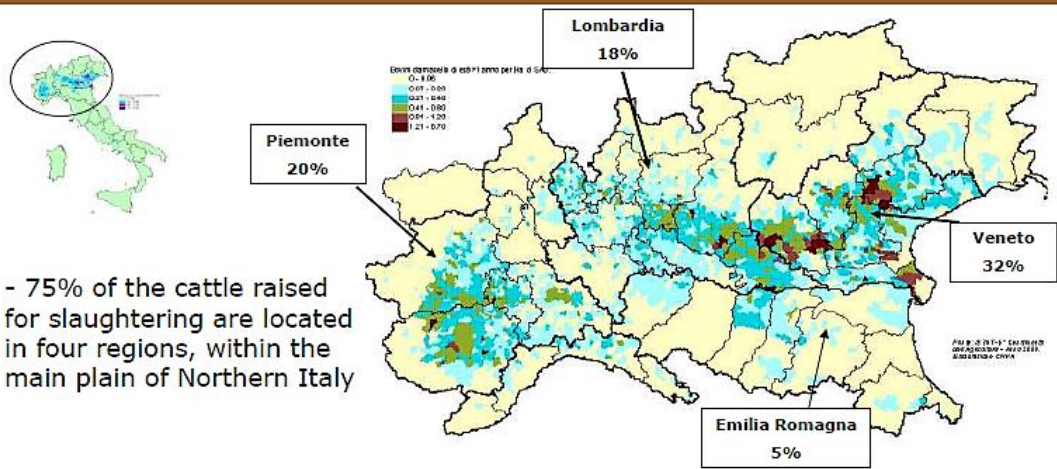
The Piemontese breed (Nerone)



Live animals in Piedmont

| | 30/06/2018 | 30/06/2019 | 2018/2019 | 2018/2019 |
|---------------------------------|------------|------------|-----------|-----------|
| | | | N | % |
| All live cattle in Piedmont | 810.471 | 810.457 | -14 | 0,00% |
| 1) PIEMONTESE | 324.786 | 327.648 | 2862 | 0,88% |
| 2) CHAROLAIS | 8.079 | 8.500 | 421 | 5,21% |
| 3) LIMOUSINE | 46.514 | 48.795 | 2281 | 4,90% |
| 4) BLONDE D'AQUITAINE/GARONNESE | 54.067 | 52.055 | -2012 | -3,72% |
| 5) AUBRAC | 3.105 | 2.903 | -202 | -6,51% |
| 6) SALERS | 976 | 909 | -67 | -6,86% |
| 7) GUASCONNE | 25 | 40 | 15 | 60,00% |

(National Data Bank - NDB)



- 75% of the cattle raised for slaughtering are located in four regions, within the main plain of Northern Italy

- In the area beef farms are mostly specialized in finishing French "broutards" (backgrounders) and weaned calves, **with the exception of the region Piemonte** that counts for the highest share of the beef cows herd .

Emilia-Romagna and Lombardia are specialized in dairy production, thus fattened mainly calves from dairy farms to produce veal and some of the young cattle imported from Eastern Europe (IDELE 2011).

Veneto is specialized in fattening broutards imported mainly from France (Charolais and Limousin breeds). The region accounted for 35% of the young bulls produced in 2011.

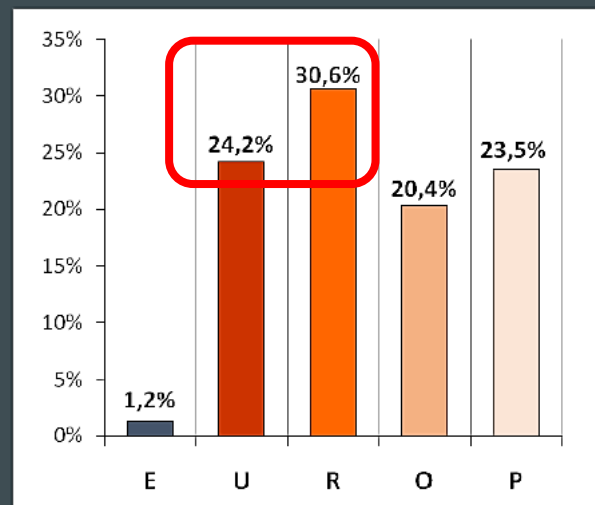
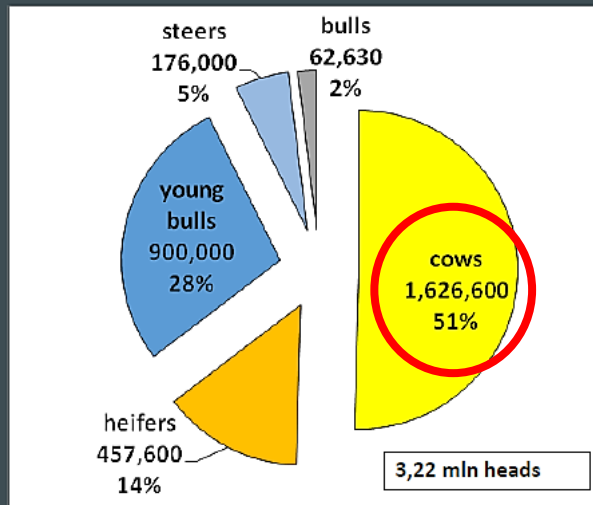
Piedmont is partly a breeder-fattening region using a local breed, the Piedmontese, and partly a fattening region from French broutards from the Blonde d'Aquitaine breed qualitatively close to the local breed.

The rest of the country represent a marginal part of the beef production in the country.

In fattening farms, young bull and heifers are allotted to be fattened for **5 to 7 months with a highly concentrated diet** allowing for a high weight gain.

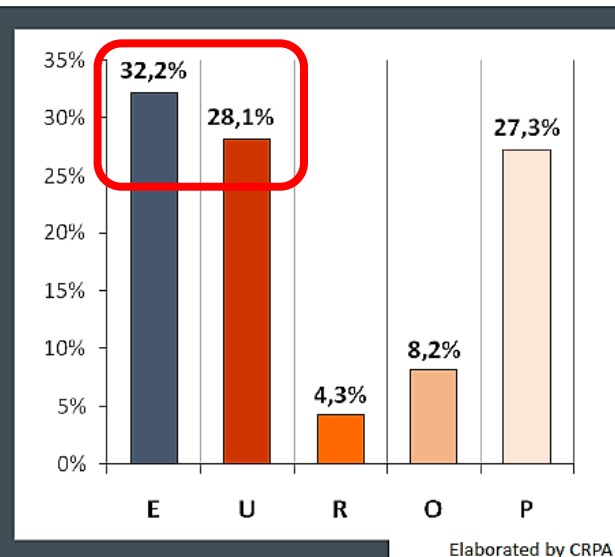
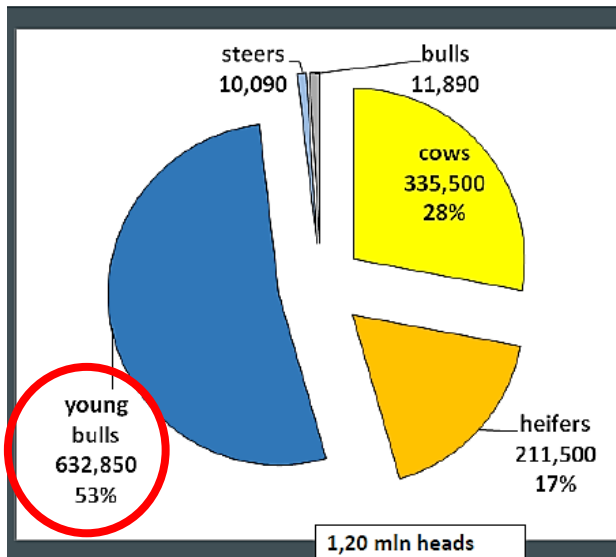
Diets are mainly based on **corn silage or flour** completed with co-products, **soybean meals and straw**.

FRANCE: Slaughtering per category and carcasses conformation (2014)



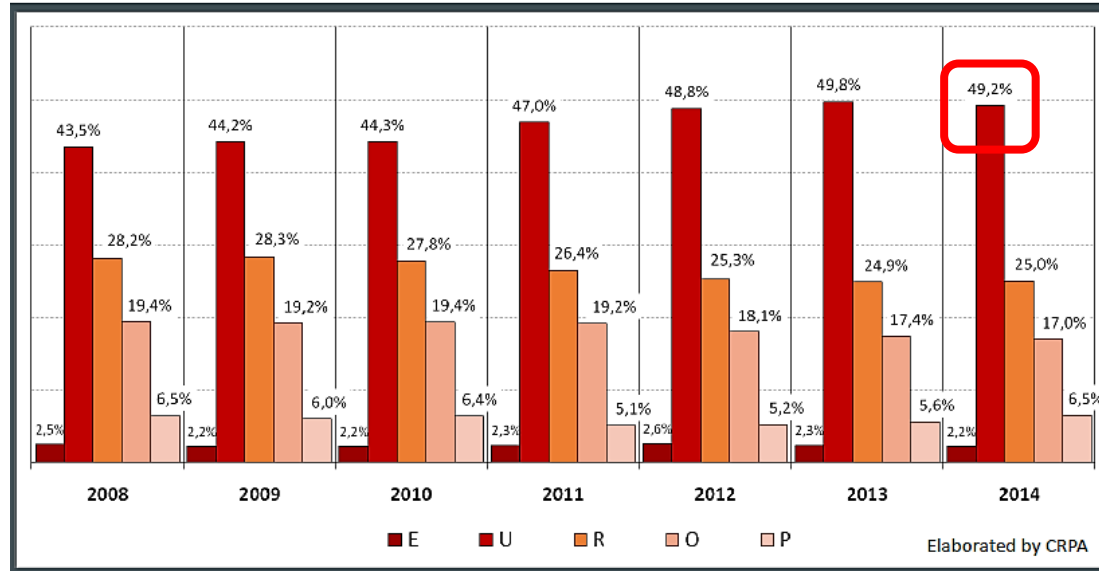
Elaborated by CRPA

ITALY: Slaughtering per category and carcasses conformation (2014)

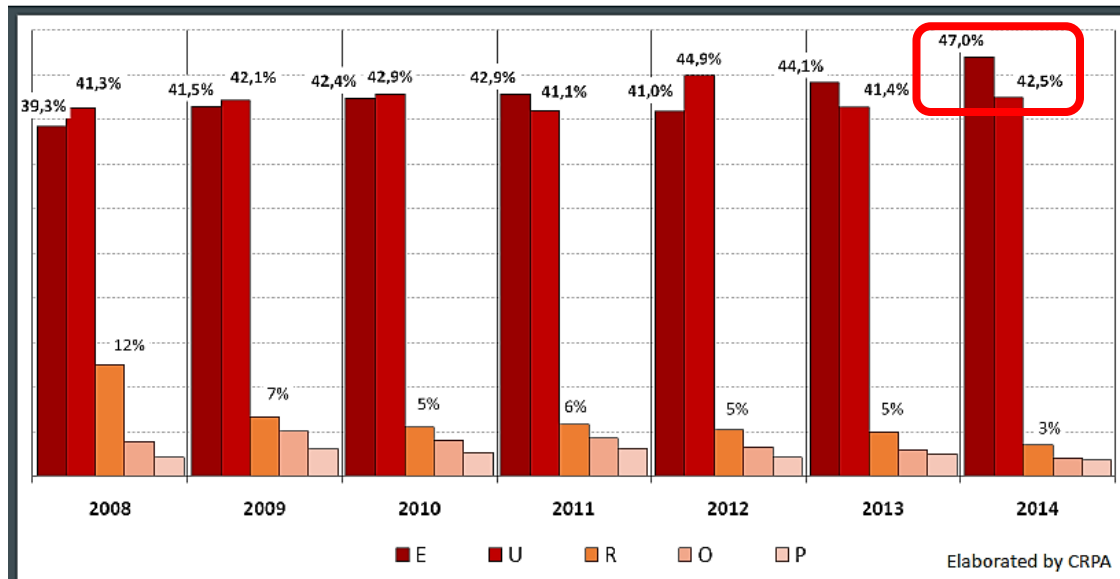


Elaborated by CRPA

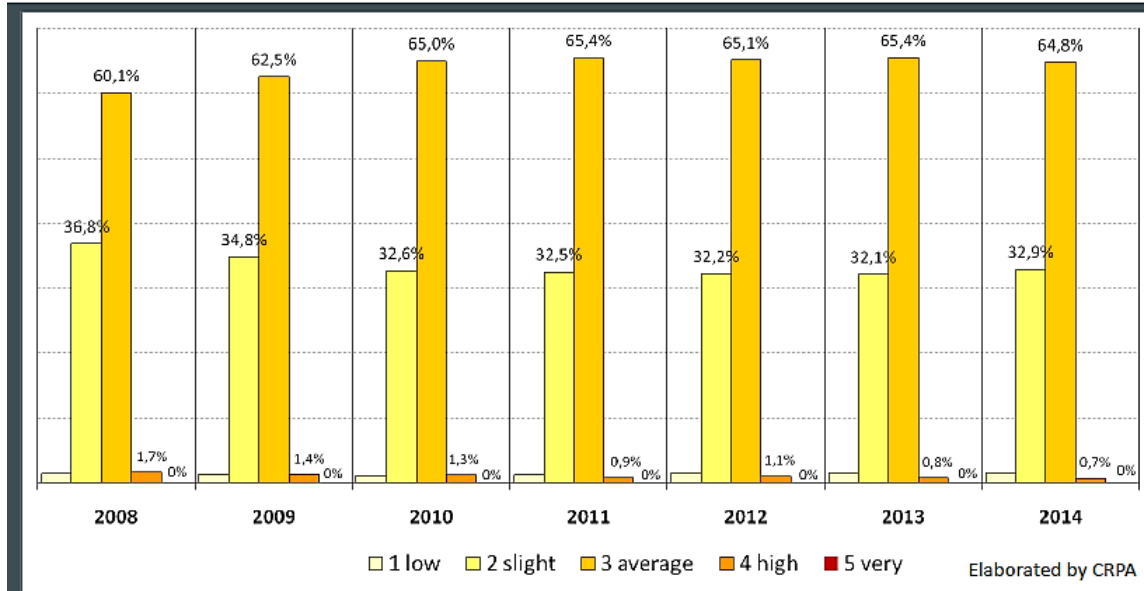
FRANCE: Young bulls carcasses conformation



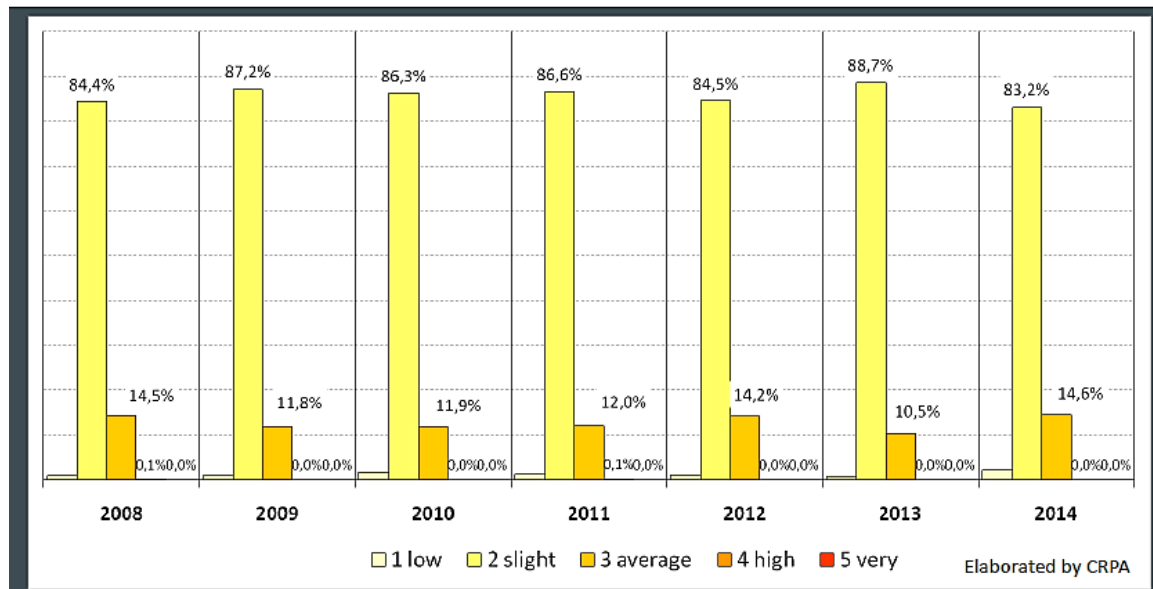
ITALY: young bulls carcasses conformation



FRANCE: Young bulls fat cover



ITALY: Young bulls fat cover





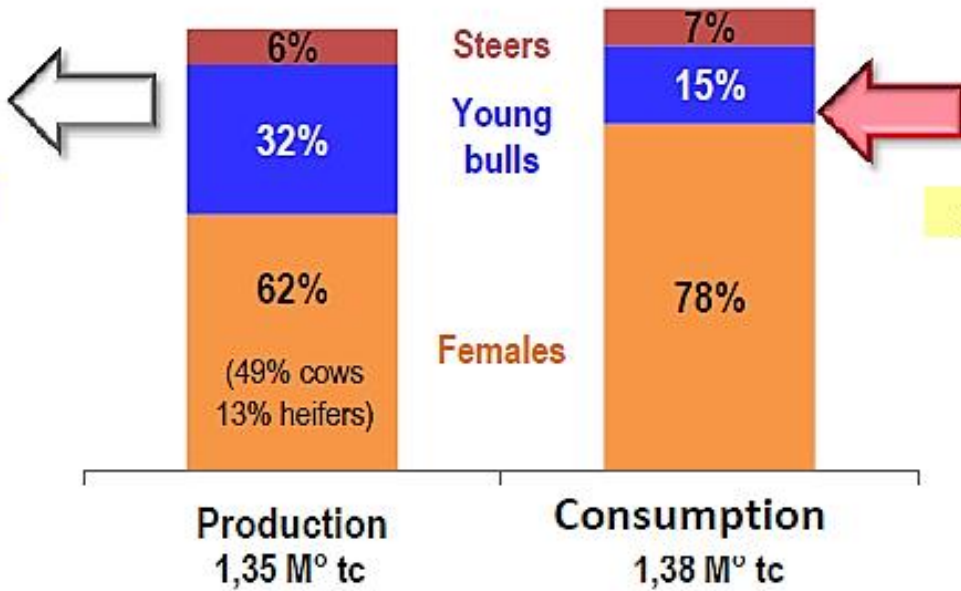
THE FRENCH DO NOT EAT WHAT THEY PRODUCE!

EXPORTS
 - **Alive cattle**
 38 000 Tc
 - **BEEF**
 268 000 Tc
 especially YB

23% of production

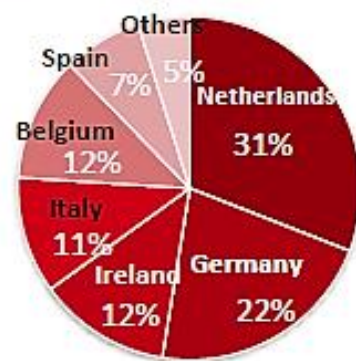


Lack : 32 000 Tc



IMPORTS
 - **BEEF**
 343 000 Tc
 especially dairy cows for minced meat and restaurants

25% of consumption



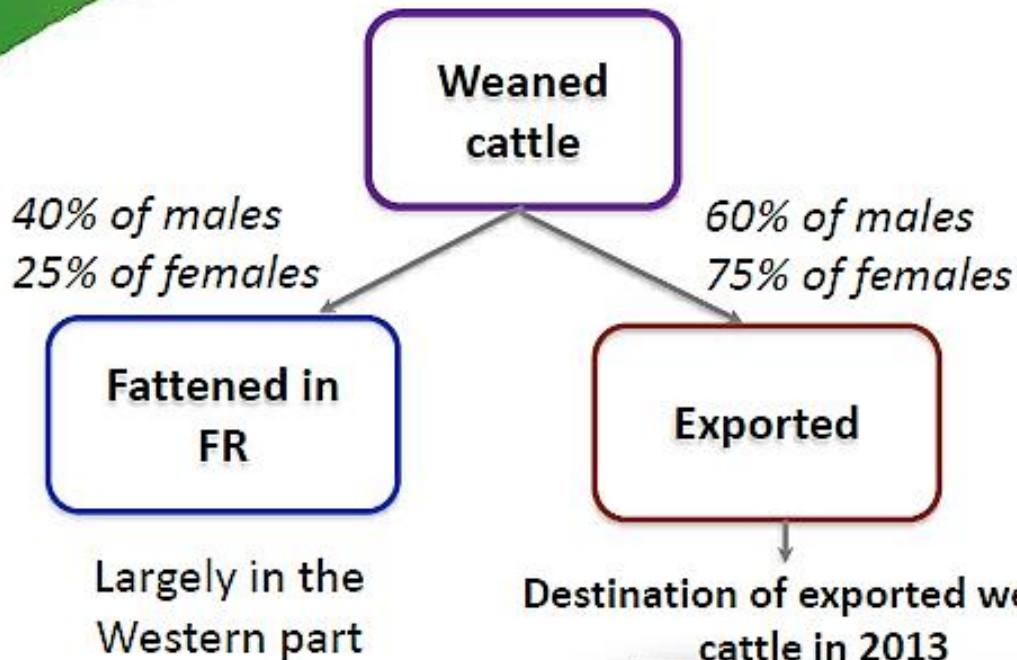
Source : SSP and Eurostat processed by idele

agri benchmark conference – June 2014 - Italy

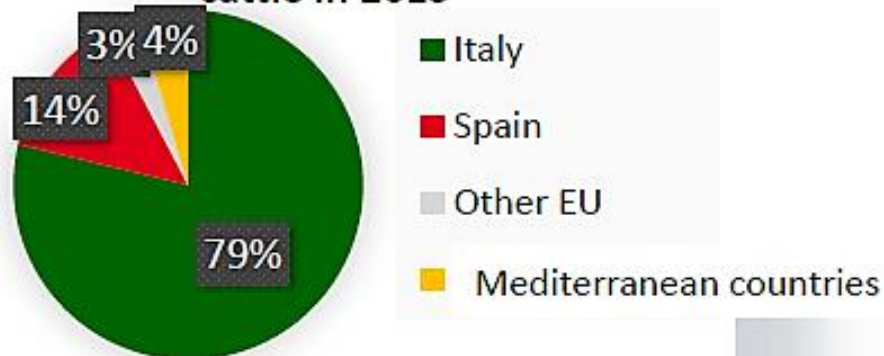




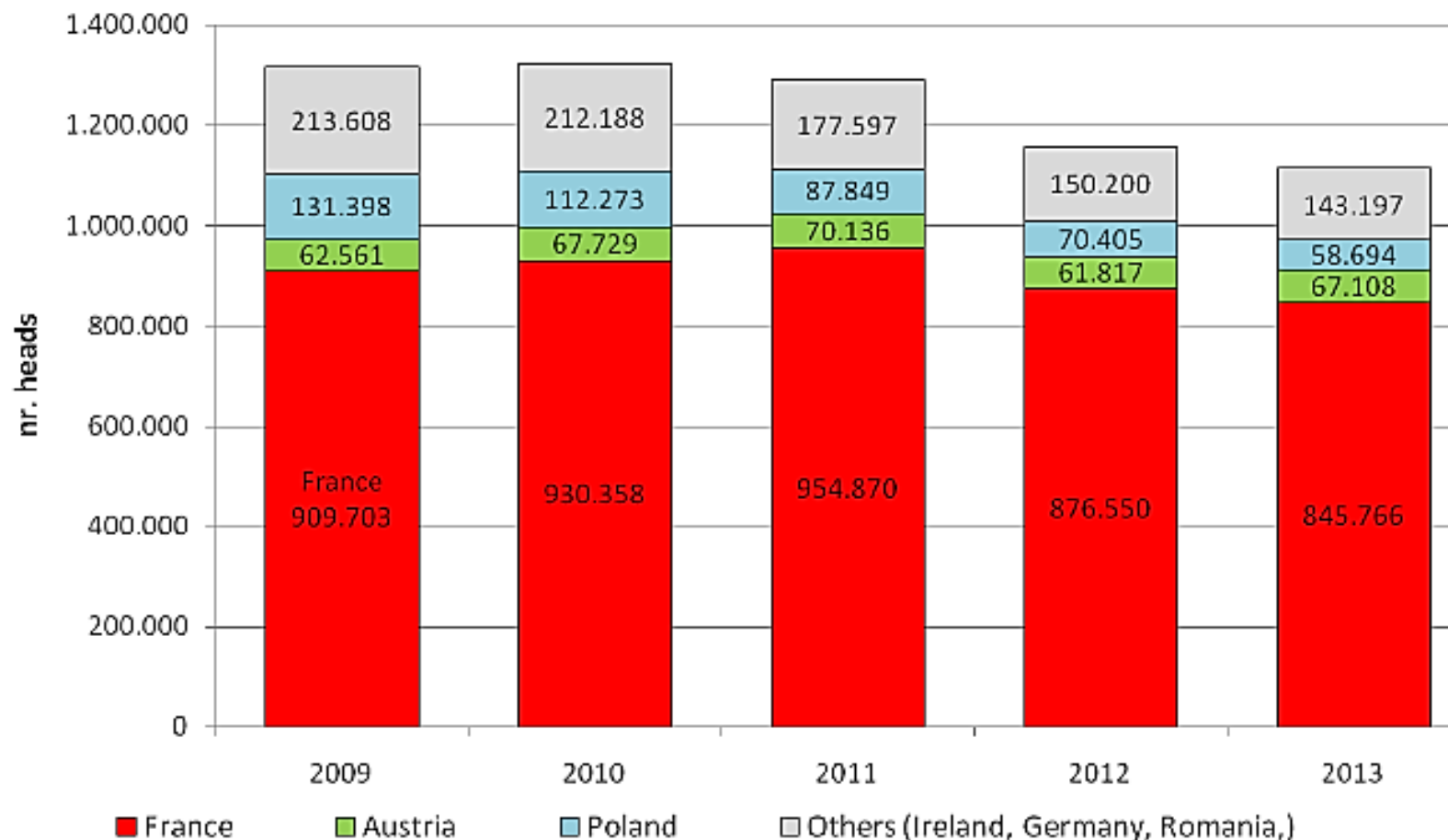
LEAN MARKETS, ESPECIALLY WEANED CATTLE SENT TO ITALY



Destination of exported weaned cattle in 2013

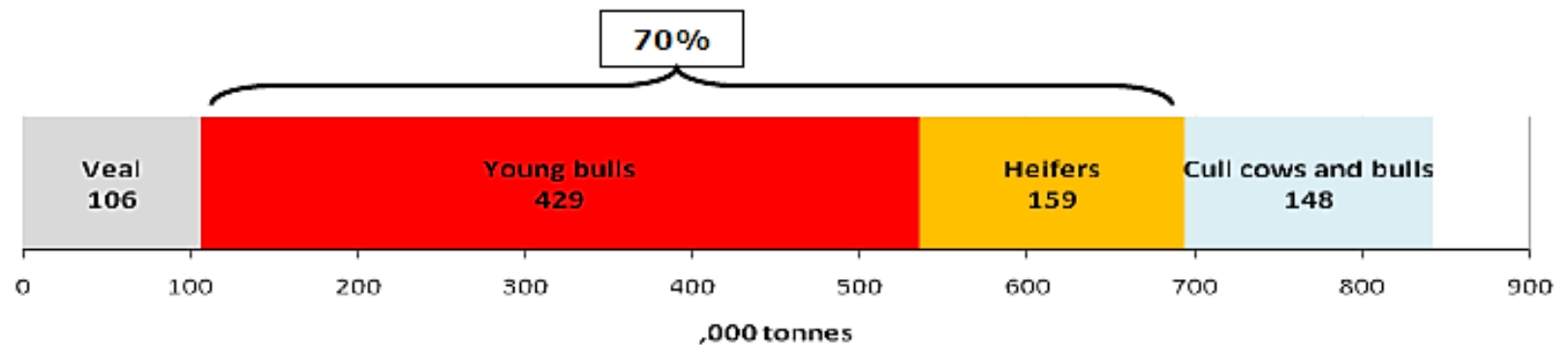


France is the main supplier of feeder cattle for Italy (75% of livestock import)



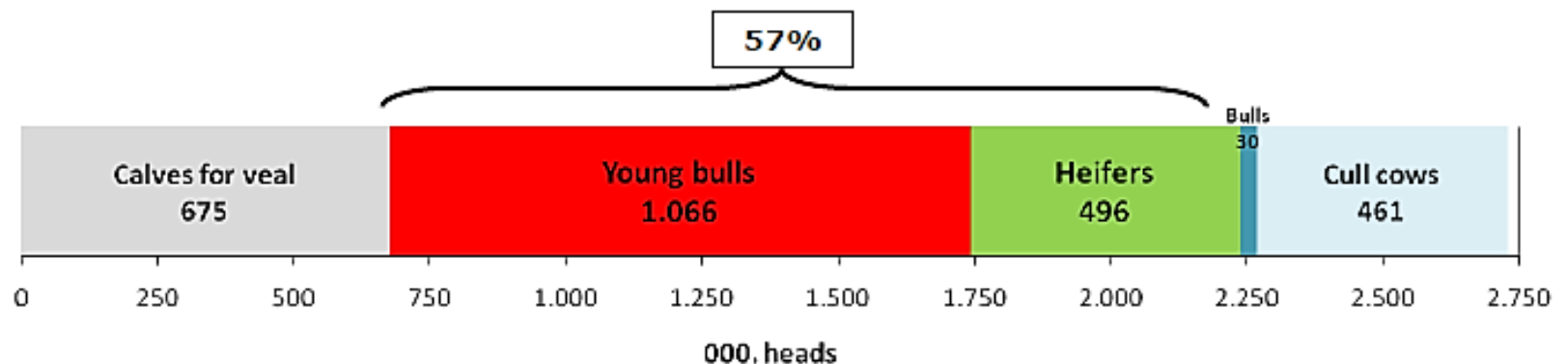
ITALY: a production based on young bulls and heifers (1-2 years)

-Total beef production in 2013: 855,000 tonnes (3rd^o producer in the EU)



-Total cattle: 2,73 mln heads

Young bulls and heifers: 1,56 mln heads



FRANCE: beef supply balance sheet

| (,000 t) | 2010 | 2011 | 2012 | 2013 | 2014 |
|------------------|-------|-------|-------|-------|-------|
| Production | 1,558 | 1,597 | 1,513 | 1,441 | 1,454 |
| Import | 408 | 375 | 383 | 378 | 360 |
| Export | 286 | 315 | 267 | 240 | 227 |
| Consumption | 1,680 | 1,657 | 1,629 | 1,579 | 1,586 |
| Self sufficiency | 93% | 96% | 93% | 91% | 92% |

Elaborated by CRPA

ITALY: beef supply balance sheet

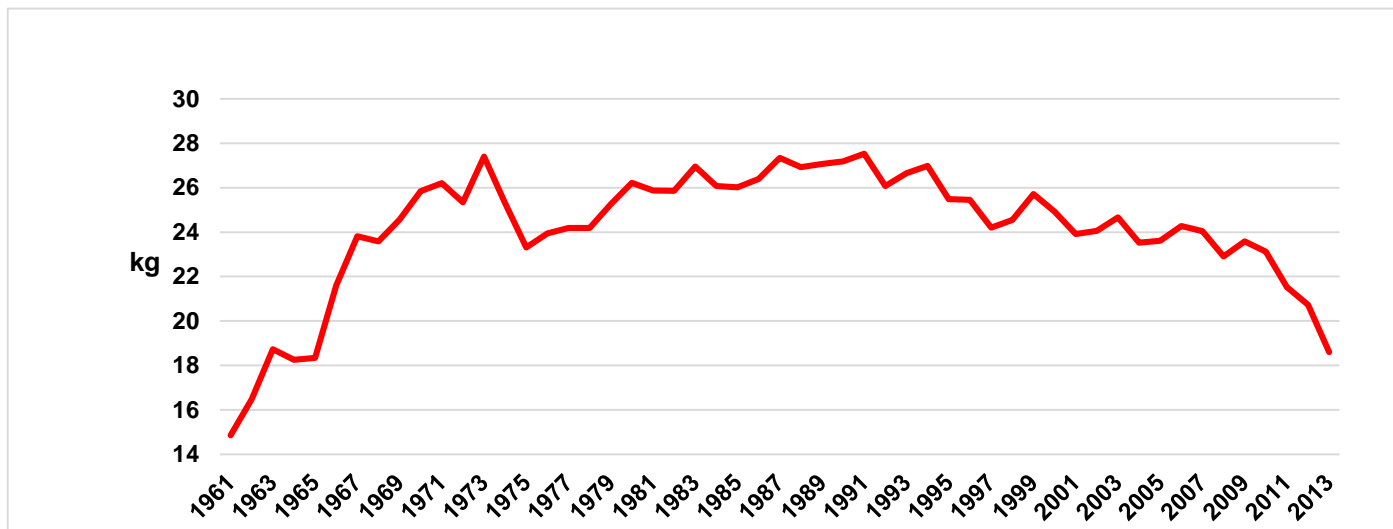
| (,000 t) | 2010 | 2011 | 2012 | 2013 | 2014 |
|------------------|-------|-------|-------|-------|-------|
| Production | 1,049 | 1,000 | 958 | 855 | 835 |
| Import | 449 | 426 | 403 | 397 | 413 |
| Export | 106 | 134 | 134 | 124 | 117 |
| Consumption | 1,392 | 1,293 | 1,227 | 1,129 | 1,131 |
| Self sufficiency | 60% | 58% | 59% | 58% | 58% |

The self-sufficiency rate of our country is around 58%.

BEEF CONSUMPTION IN ITALY



Apparent consumption of beef in Italy





In Italy beef consumption has changed enormously from the end of the Second World War to current days.

During the sixties it greatly increased witnessing the end of "poverty" and the increase of per capita income.

From the sixties to the beginning of the nineties, when meat was a status symbol of well-being, the per capita consumption of beef increased from about 20 to 27 kg/year.

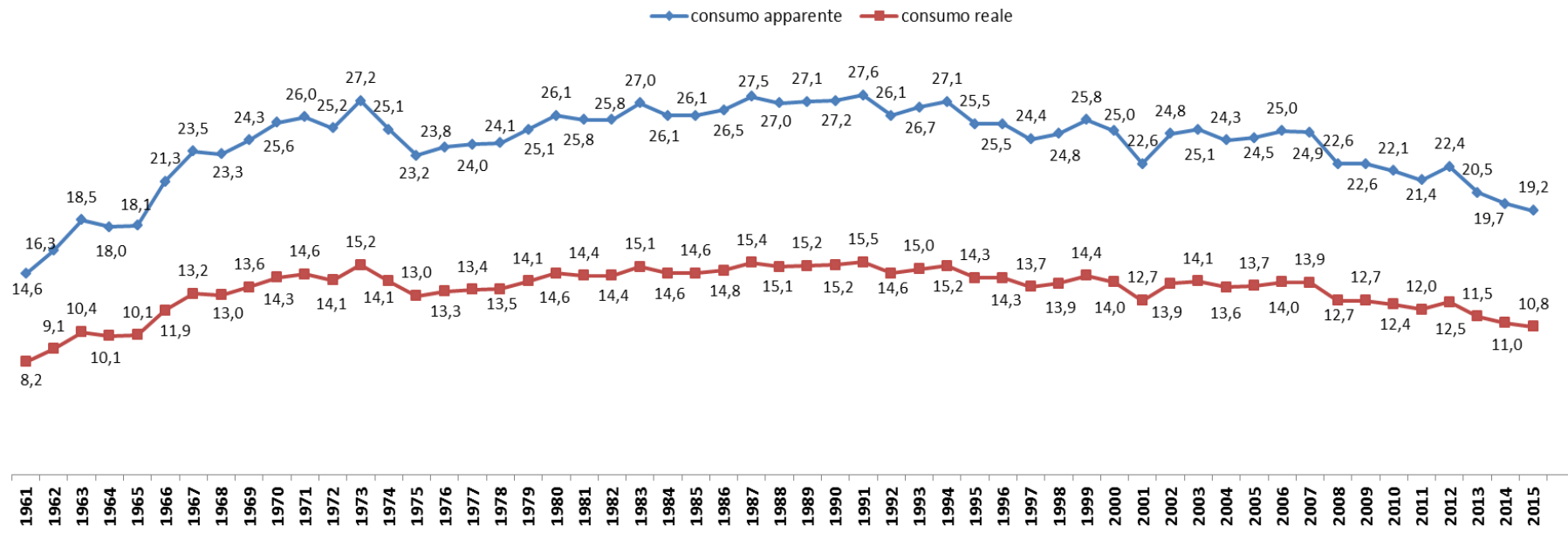
However, after 30-year rise, a serious sustained decline has now occurred, so much that between 2000 and 2014 the per capita consumption decreased from 25 to 21 kg (-16%).

|  |  |
|--|--|
| AUSTRIA | 17 |
| BELGIUM/LUX | 15 |
| BULGARIA | 3 |
| CYPRUS | 8 |
| CROAZIA | 12 |
| DENMARK | 25 |
| ESTONIA | 6 |
| FINLAND | 18 |
| FRANCE | 25 |
| GERMANY | 13 |
| GREECE | 14 |
| IRELAND | 21 |
| ITALY | 20 |
| LATVIA | 6 |
| LITHUANIA | 5 |
| MALTA | 13 |
| NETHERLANDS | 19 |
| POLAND | 3 |
| PORTUGAL | 15 |
| UNITED KINGDOM | 17 |
| CZECH REP. | 8 |
| RUMANIA | 7 |
| SLOVAKIA | 3 |
| SLOVENIA | 18 |
| SPAIN | 12 |
| SWEDEN | 26 |
| HUNGARY | 3 |

Main reasons why consumers reduced beef consumption

- negative impact of food scandals involving beef;
- presence of harmful residues;
- inconsistency of eating quality;
- new food habits of young generations;
- environmental and ethical issues related with animal production;
- negative effects of the economic recession;
- health concerns, mainly related to the total fat content and to the supposed negative effects exerted by saturated fatty acids (SFA), *trans* fatty acids and cholesterol.

Apparent vs Real consumption of beef in Italy



Apparent consumption includes non-edible parts of the carcass.

Apparent consumption overestimates the **real meat consumption** because it include non-edible parts (**bones, cartilages, connective tissue, etc**), processing losses and waste.

In 2015 **real beef consumption** was about 10-11 kg per capita/year or 30 g/day.

Real consumption of all the meat was about 38 kg/year (103 g/day).

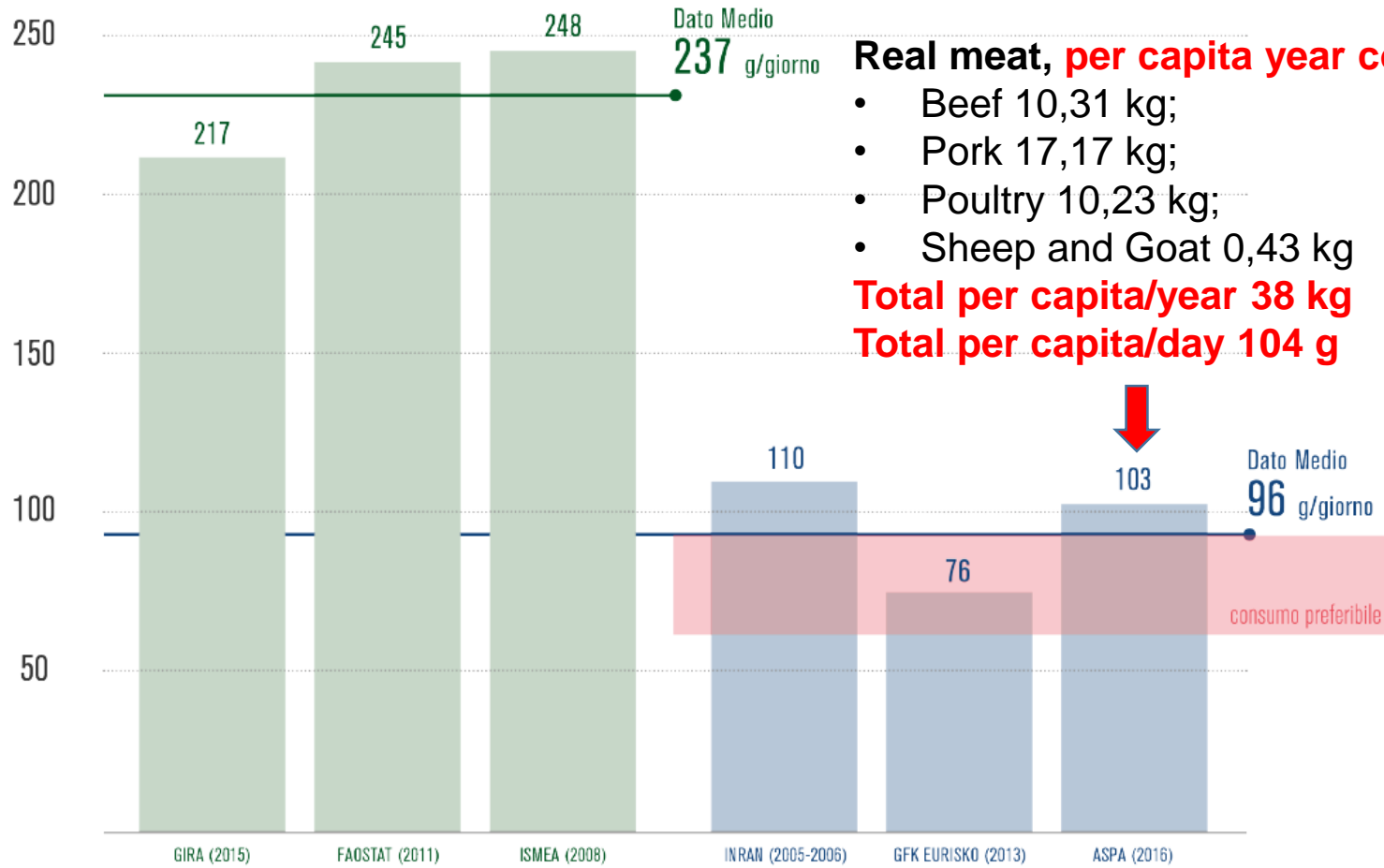
Real meat consumption per capita in Italy in the period 2010-2013 (kg)

| Meat | 2010 | 2011 | 2012 | 2013 | Average |
|---------------------------|-------|-------|-------|-------|---------|
| Bovine ¹ | 12,12 | 11,23 | 10,85 | 10,31 | 11,13 |
| Pig | 18,14 | 17,61 | 17,22 | 17,17 | 17,53 |
| Poultry | 9,64 | 10,22 | 10,64 | 10,23 | 10,18 |
| Mutton and goat | 0,57 | 0,54 | 0,51 | 0,43 | 0,51 |
| Horse | 0,58 | 0,56 | 0,56 | 0,49 | 0,55 |
| Rabbit | 0,31 | 0,31 | 0,30 | 0,28 | 0,30 |
| Wild Animasi ² | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Total | 41,41 | 40,52 | 40,13 | 38,96 | 40,25 |

¹ It includes buffalo meat; ² equal estimate all years

In the four years period considered the **real meat consumption** per capita decreased.

The decrease has mainly affected the **beef** (1,81 kg) and **pork** (0,97 kg).



Real meat, per capita year consumption

- Beef 10,31 kg;
- Pork 17,17 kg;
- Poultry 10,23 kg;
- Sheep and Goat 0,43 kg

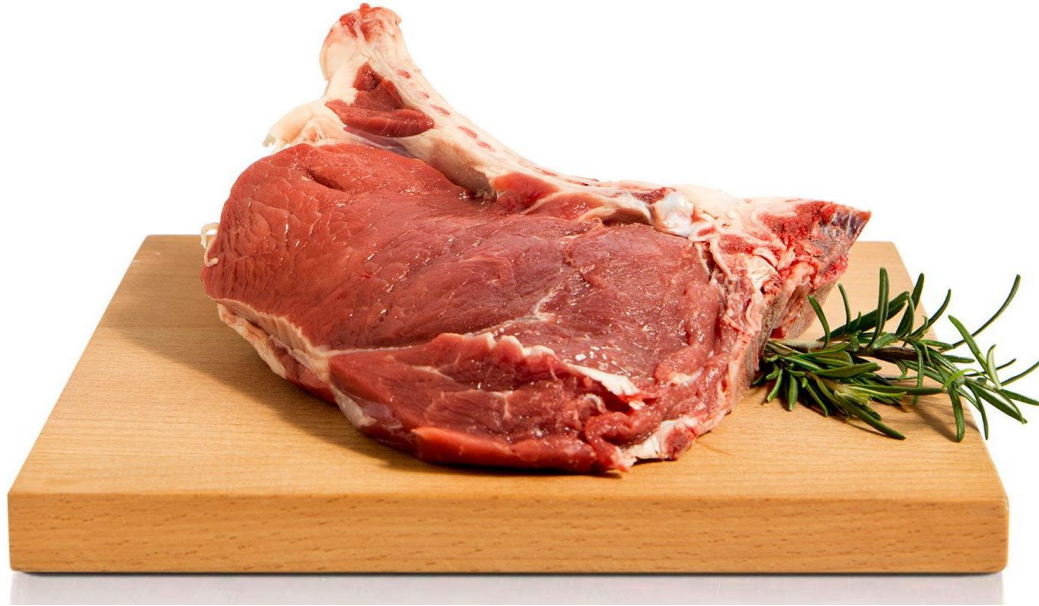
Total per capita/year 38 kg

Total per capita/day 104 g



Beef: Italy consumes much lower quantities than other European countries

WHAT IS MEAT?



The Definitions of Meat in Europe

What is meat for the legislator?

The Annex I of Regulation (EC) No. 853/2004 (EU, 2004) **defines meat as all the edible parts of animals, including the blood.**

The following **categories** are all considered meat under EC:

- Domestic ungulates of the cattle (including *Bubalus* spp. and *Bison* spp.), swine, ovine, and caprine species, as well as domestic solipeds (horse, donkey, and mule);
- Poultry, farmed birds, including birds that are not considered domestic but which are reared as domestic animals, with the exception of ratites;
- Lagomorphs, i.e., rabbits and hares, but also rodents;
- Wild game, i.e., wild ungulates, lagomorphs, and wild birds subjected to hunting for human consumption;
- Farmed game, i.e., farmed ratites and farmed land mammals;
- Small wild game, i.e., free wild birds and free lagomorphs;
- Large wild game, i.e., free wild land mammals.

The Regulation (EC) No. 853/2004 (EU, 2004) also **defines fresh meat** as:

- all meats that have not undergone any preserving process, apart from chilling, freezing, or quick-freezing;
- meat that is vacuum-wrapped or wrapped in a controlled atmosphere.

Fresh meat includes the meat coming from the carcass of an animal, as well as its offal.

The term **offal refers to fresh meat** other than that of the carcass, including:

- viscera, the organs of the thoracic, abdominal, and pelvic cavities, as well as the trachea and esophagus, and, in birds, the crop;
- blood.

What is meat for food scientists?

Food scientists provide a different definition of meat

They consider meat exclusively the muscular mass and all the connected edible tissues of animal carcasses, whereas offal is classified into three categories:

1. offal (liver, kidneys, spleen, brain, lungs, and heart);
2. sweetbreads (pancreas, thymus, and salivary glands);
3. tripes (stomach and pre-stomachs of ruminants and the upper part of the small intestine).

Such discrepancies in defining fresh meat are due to the difference in purpose of the Regulation (EC) No. 853/2004 (EU, 2004) from that of scientists.

The focus of the Regulation (EC) No. 853/2004 is to lay down specific hygiene rules for the hygiene of foodstuffs, whereas the focus of scientists is to give meat a scientific or commodity definition.

WHAT IS QUALITY?

Quality

=



The Definitions of Quality

Many authors have attempted to define or describe the concept of quality

Garvin (1984) describes five complementary approaches to defining quality:

I. Transcendent Definition:

- “Quality is neither mind nor matter, but a third entity independent of the two . . . even though Quality cannot be defined, you know what it is.” (R. M. Pirsig, *Zen and the Art of Motorcycle Maintenance*, pp. 185, 213)
- “. . . a condition of excellence implying fine quality as distinct from poor quality. . . . Quality is achieving or reaching for the highest standard as against being satisfied with the sloppy or fraudulent.” (B. W. Tuchman, “The Decline of Quality,” *New York Times Magazine*, 2 November 1980, p. 38)

II. Product-based Definition:

- “Differences in quality amount to differences in the quantity of some desired ingredient or attribute.” (L. Abbott, *Quality and Competition*, pp. 126–127)
- “Quality refers to the amounts of the unpriced attributes contained in each unit of the priced attribute.” (K. B. Leffler, “Ambiguous Changes in Product Quality,” *American Economic Review*, December 1982, p. 956)

III. User-based Definition:

- “Quality consists of the capacity to satisfy wants . . .” (C. D. Edwards, “The Meaning of Quality,” *Quality Progress*, October 1968, p. 37)
- “Quality is the degree to which a specific product satisfies the wants of a specific consumer.” (H. L. Gilmore, “Product Conformance Cost,” *Quality Progress*, June 1974, p. 16)
- “Quality is any aspect of a product, including the services included in the contract of sales, which influences the demand curve.” (R. Dorfman and P. O. Steiner, “Optimal Advertising and Optimal Quality,” *American Economic Review*, December 1954, p. 831)
- “In the final analysis of the marketplace, the quality of a product depends on how well it fits patterns of consumer preferences.” (A. A. Kuenn and R. L. Day, “Strategy of Product Quality,” *Harvard Business Review*, November–December 1962, p. 101)
- “Quality consists of the extent to which a specimen [a product-brand-model-seller combination] possesses the service characteristics you desire.” (E. S. Maynes, “The Concept and Measurement of Product Quality,” in *Household Production and Consumption*, p. 5+2)
- “Quality is fitness for use.” (J. M. Juran, ed., *Quality Control Handbook*, p. 2–2)

IV. Manufacturing-based Definition:

- “Quality [means] conformance to requirements.” (P. B. Crosby, *Quality Is Free*, p. 15)
- “Quality is the degree to which a specific product conforms to a design or specification.” (Gilmore, June 1974, p. 16)

V. Value-based Definition:

- “Quality is the degree of excellence at an acceptable price and the control of variability at an acceptable cost.” (R. A. Broh, *Managing Quality for Higher Profits*, 1982, p. 3)
- “Quality means best for certain customer conditions. These conditions are (a) the actual use and (b) the selling price of the product.” (A. V. Feigenbaum, *Total Quality Control*, p. 1)

Generally the definitions for quality can be summarized as:

- **“Quality is meeting or exceeding customers’ expectations”**
- **“The degree to which a specific product satisfies the needs and expectations of a particular buyer”.**

To meet or exceed customer’s expectations it is important **to know who are the customers and what they expect.**

Customers can be defined as those who receive a product or a service from a supplier within a production chain.

Customer that are the ultimate purchaser or user of a product or service are referred to as consumers.

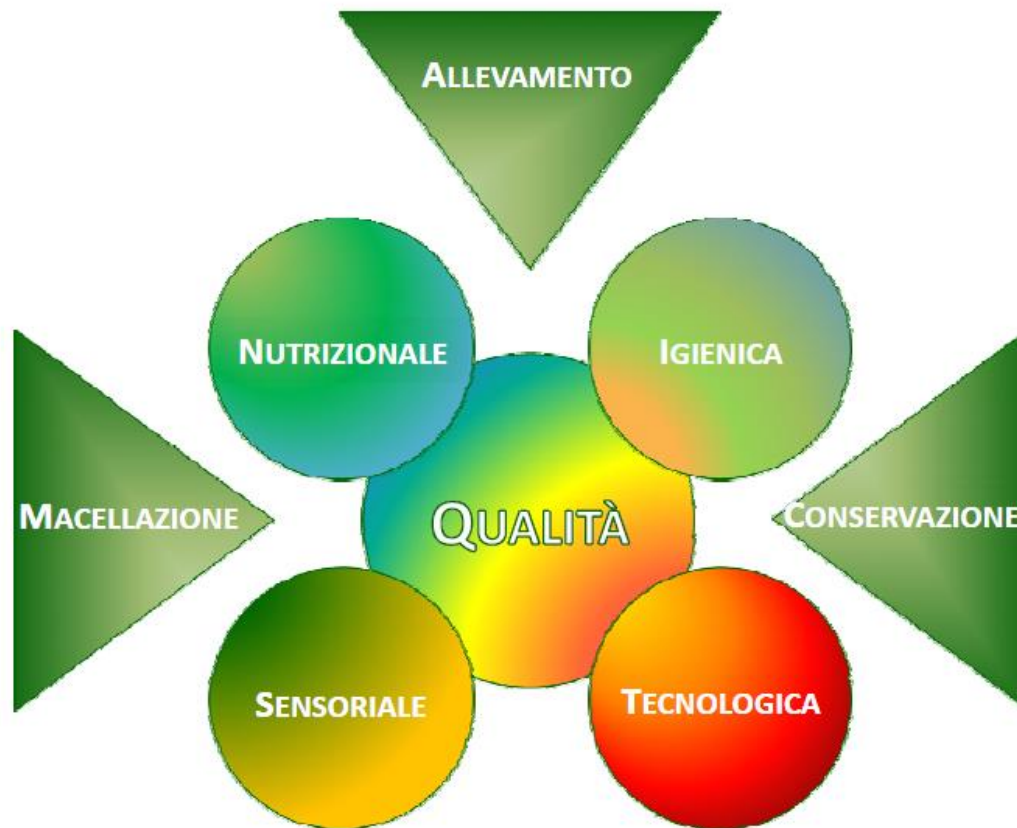
The consumer doesn’t exist and there is no average consumer.

According to Jongen (1998), there is a specific consumer, which in a specific situation and on a certain moment has a specific need to which the producer can respond.

As our personal and communal preferences and appreciations change with changes in society, it is axiomatic that the definition of food quality can also change.

WHAT IS MEAT QUALITY?

Qualità della carne



What is meat quality?

Meat quality can be defined as a set of properties that together identify what we appreciate about meat when we purchase it, eat it, or select it for use as raw material for processing into meat products.

Traditionally, the set of properties used to define the quality of meat intended for consumption as whole meat, rather than meat products, are those associated with our sensory perception:

- Appearance;
- Colour;
- Flavour;
- Texture, especially tenderness;
- Juiciness;
- Odour.

These attributes can be defined as **intrinsic attributes (those parameters that we could see, taste or smell)** and are directly related to the physical product properties (**appearance, colour, size, flavour, texture, juiciness**).

The extrinsic attributes (they cannot immediately be detected by physical or sensory examination of the meat itself) are associated with the **way that the meat is produced** and also other aspects, like **environmental impact** or **marketing influence**.

They do not necessarily have a direct influence on physical properties but can affect acceptance of products by consumers.

These extrinsic factors center around **animal welfare**, the **nutritional value of meat** in the human diet, and **ecological sustainability** of production systems.

In other words, the **well-being of meat animals**, the **well-being of meat consumers**, and the **well-being of society** as a whole are now principal attributes of meat production system and the final product itself.

The **other traditional quality factor**, normally expressed as freshness or wholesomeness, relates to the perception that the meat is safe to eat, in terms of lack of pathogens, parasites, infection agents, or toxins.

The balance among meat availability, wholesomeness, and intrinsic and extrinsic factors varies from country to country, depending on local customs and on the state of the local economy.

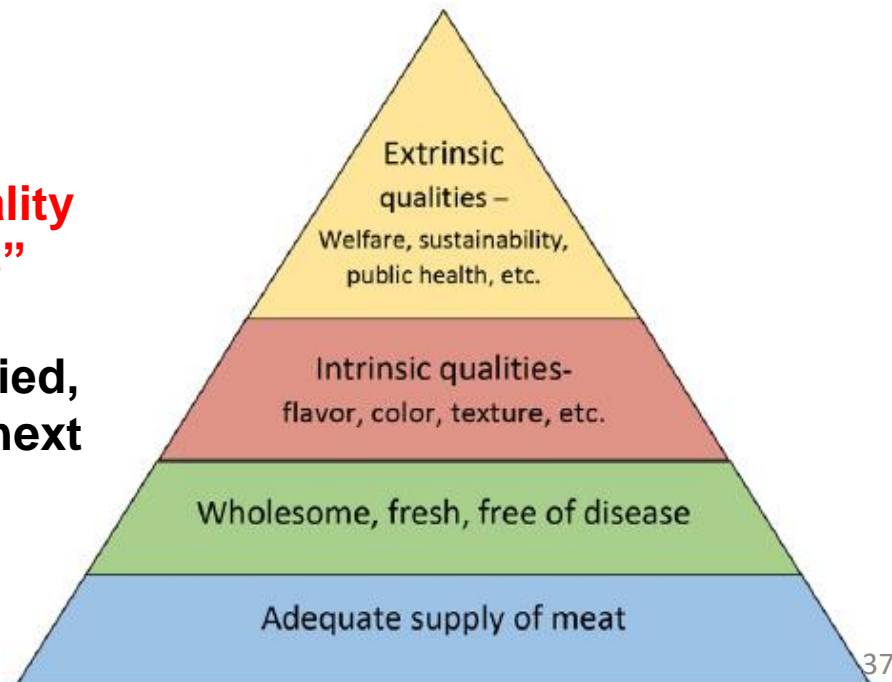
In some developing countries, the **price** of meat and its **availability** or **continuity of supply** are the most important factors for consumers.

When the continuity of supply is secure, **wholesomeness** or **freshness** is the next major concern.

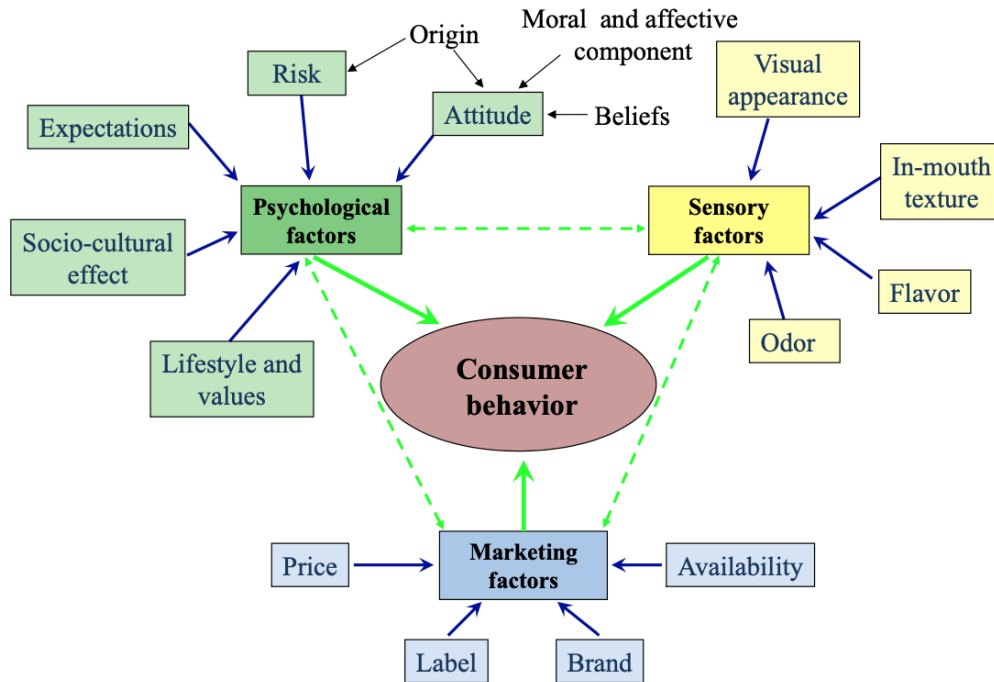
If this is also satisfied then the traditional (intrinsic) **eating qualities** become important.

Consumer perceptions of meat quality represented as a “triangle of needs”

When each level of “need” is satisfied, it becomes less dominant and the next level up takes on more importance.



The concept of “meat quality” evolved and became more and more complex in the last decades.



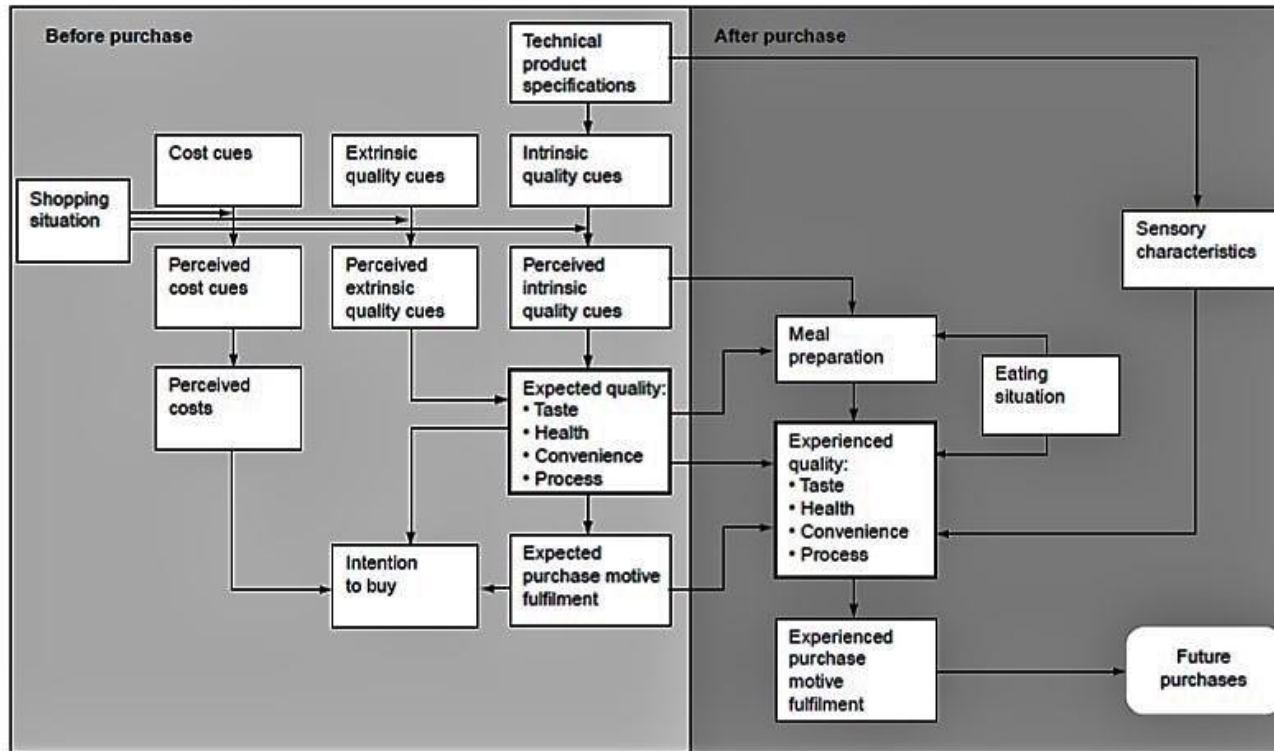
It moved from just “eating quality” to include several aspects as safety, ethics and nutritional characteristics.

Perceived quality by the consumers is nowadays a **multifactorial complex** and all the involved factors affect purchase choice and willingness to pay for meat, driving therefore meat demand and profitability along the supply chain.

The **improvement of perceived quality** is therefore fundamental, both to satisfy consumers’ expectations and to guarantee profitability to all the operators of the supply chain and the related allied industries.

In the building of a modern concept of quality, the canonical sensory quality is nowadays accompanied by extrinsic psychological and marketing factors, more connected with the production system instead of the meat intrinsic characteristics.

The Total Food Quality Model (Grunert, 2005)



The TQM distinguishes between two concepts of quality perceptions or evaluations, namely **expected quality** (at the buying stage) and **experienced quality** (after consumption). The **horizontal dimension** is a **time dimension**.

The **vertical dimension** deals with how consumers infer quality from a variety of signals or **cues**, and with how consumers find out which properties of a food are desirable by linking them to the basic motivators of human behaviour.

Groups of Meat Quality Characteristics

Quality Categories

Individual Attributes

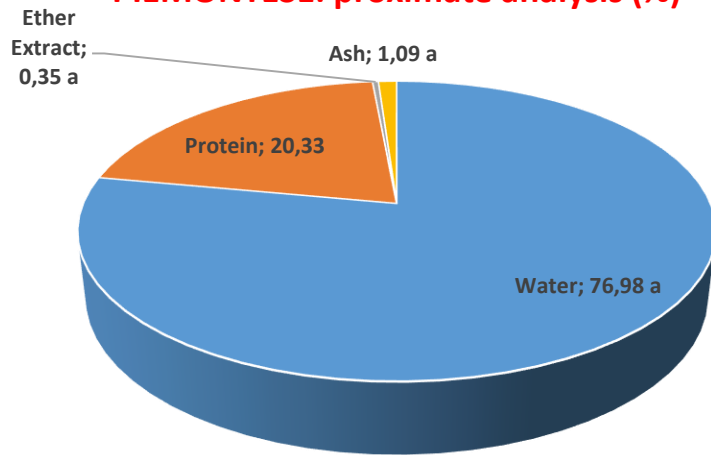
| | |
|------------------------|---|
| Sensory quality | Raw meat: visual texture, color, visible fat, natural drip Heated meat: aroma, flavor, texture |
| Technological quality | WHC, pH value, protein, lipid and connective tissue properties, antioxidative status, emulsifying capacity, gel formation capacity |
| Nutritional quality | Protein, moisture and lipid content, vitamins, minerals, digestibility |
| Product safety | Microbiological quality, pesticides, heavy metal ions, antibiotics, hormones |
| Ethical considerations | General welfare: handling, farming system, transport, slaughter practices Farming system: feedlot, free range, organic farming, and outdoor rearing Slaughter procedure: general handling and killing method, for example, Kosher |

The various quality categories are affected by several intrinsic and extrinsic factors:

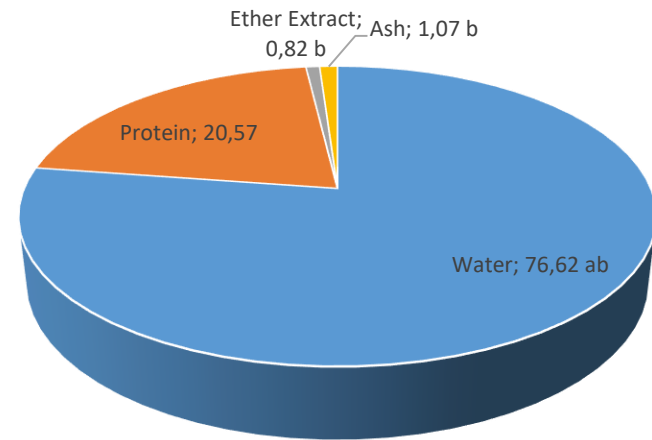
- **Intrinsic factors:** breed, genotype, age and sex;
- **Extrinsic factors:** rearing system, feeding regime, pre-slaughter conditions, slaughter procedure, chilling and post slaughter handling of the meat.



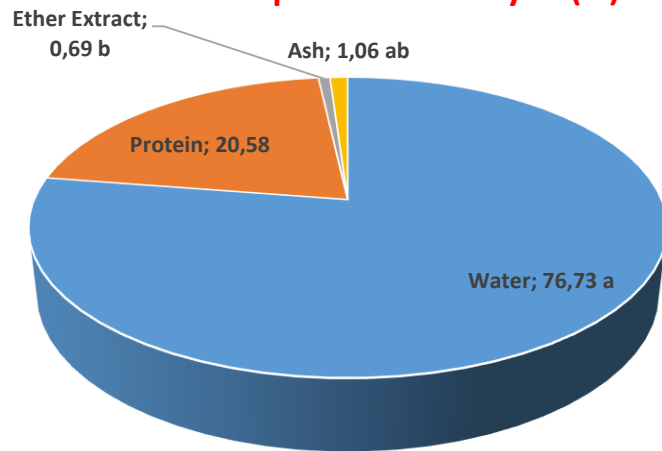
PIEMONTESE: proximate analysis (%)



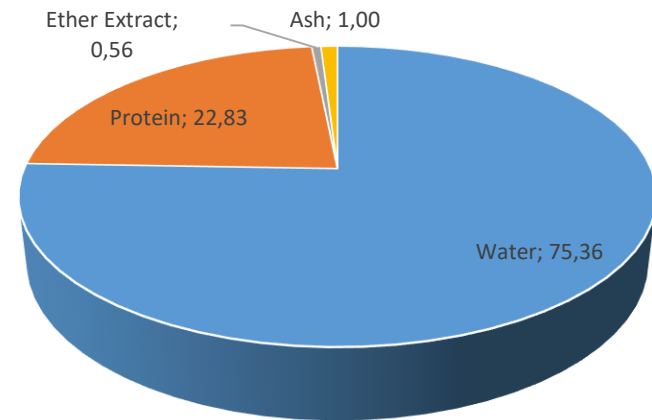
CHAROLAISE: proximate analysis (%)



LIMOUSINE: proximate analysis (%)



BLONDE D'AQUITAINE: proximate analysis (%)



High Protein/Dry Matter: 88% (P, C and L) ÷ 93% (BA);
Very low fat content (<1% in the *longissimus thoracis et lumborum* muscle);
Low energy content: 100 g of meat supplied only 84 kcal (P) ÷ 96 kcal (BA);
Energy from protein: protein provided 96% (P) ÷ 92% (C) of the energy.

| FATTY ACIDS and CHOLESTEROL (mg/100 g meat) | | |
|--|------------|-----------|
| | PIEMONTESE | LIMOUSINE |
| Fat (%) | 1,1 a | 1,7 b |
| SFA | 468,86 a | 766,49 b |
| MUFA | 336,91 a | 585,44 b |
| PUFA | 200,08 | 203,07 |
| PUFA/SFA | 0,49 | 0,32 |
| C18:2 n-6 (LA) | 153,75 | 147,24 |
| C18:3 n-3 (ALA) | 5,38 | 5,51 |
| Σ n-6 PUFA | 187,74 | 188,29 |
| Σ n-3 PUFA | 9,25 | 11,21 |
| n-6/n-3 PUFA | 22,9 b | 17,07 a |
| Cholesterol | 50,98 | 50,86 |

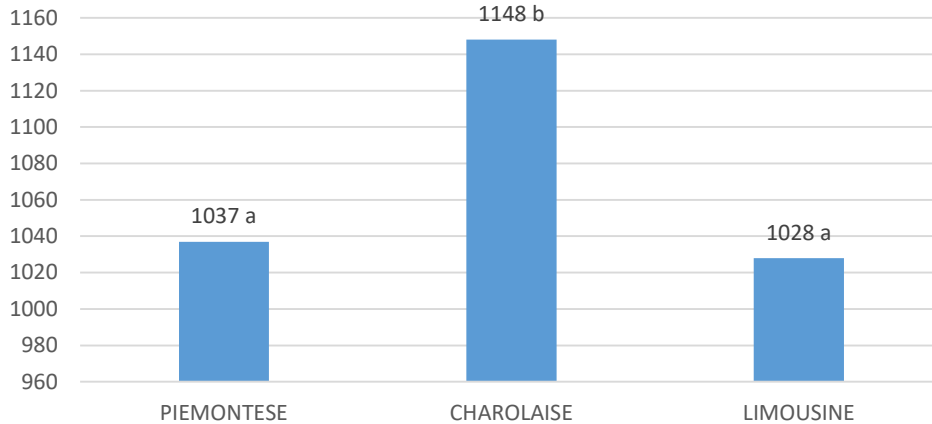
| PIEMONTESE: FATTY ACIDS (mg/100 g meat) | | |
|--|----------|----------|
| | Control | Flaxseed |
| Fat (%) | 0,52 | 0,46 |
| SFA | 231,26 | 191,26 |
| MUFA | 189 | 137,36 |
| PUFA | 165,3 | 150,36 |
| PUFA/SFA | 0,74 | 0,81 |
| C18:2 n-6 (LA) | 122,53 b | 102,16 a |
| C18:3 n-3 (ALA) | 4,9 A | 14,24 B |
| Σ n-6 PUFA | 151,62 b | 126,13 a |
| Σ n-3 PUFA | 11,85 A | 22,13 B |
| n-6/n-3 PUFA | 13,13 B | 5,6 A |

The Department of Health of the United Kingdom set a recommended ratio of:

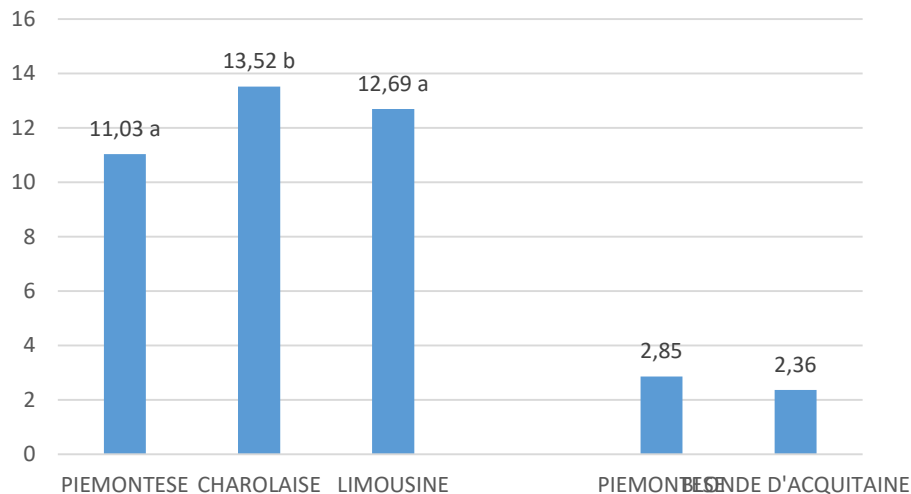
- PUFA/SFA > 0,45
- n-6/n-3 < 4,0.

Including flaxseed in the diet (n-3 PUFA) it is possible to reduce this ratio.

Hydroxyproline ($\mu\text{g/g}$)



Warner-Bratzler shear force (P; C; L, \varnothing 2,54 cm; P; BA \varnothing cm 1,27; kg)



Collagen content:

- Piemontese = 7,78 mg/g
- Charolaise = 8,61 mg/g

Collagen/Protein:

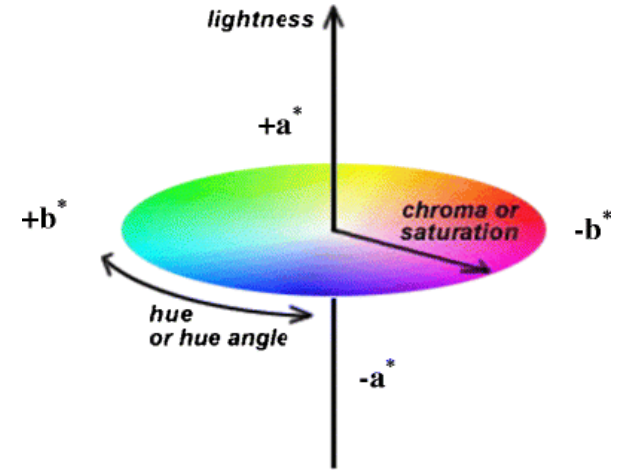
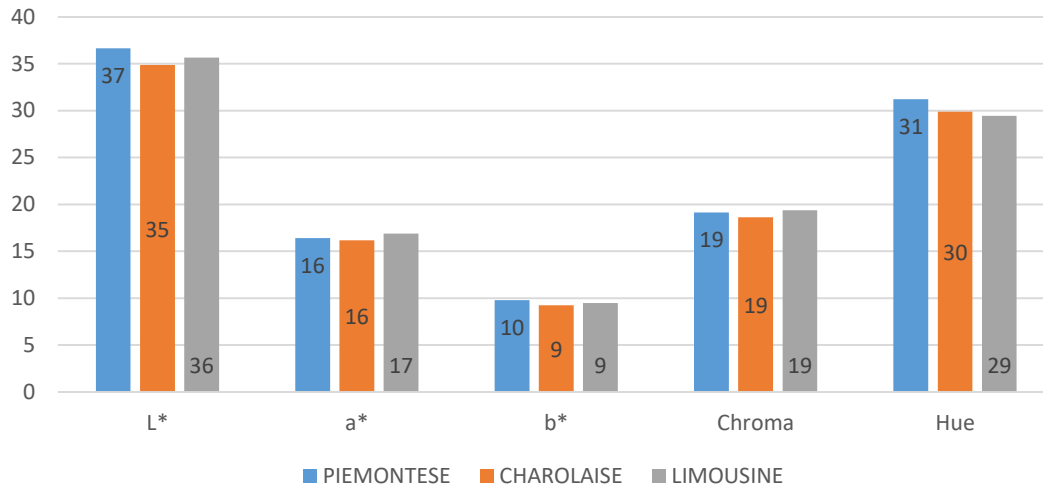
- Piemontese = 3,82 %
- Charolaise = 4,24 %

Collagen/Protein ratio is an index of protein quality, as the collagen is lacking of tryptophan and poor in sulphur amino acids.

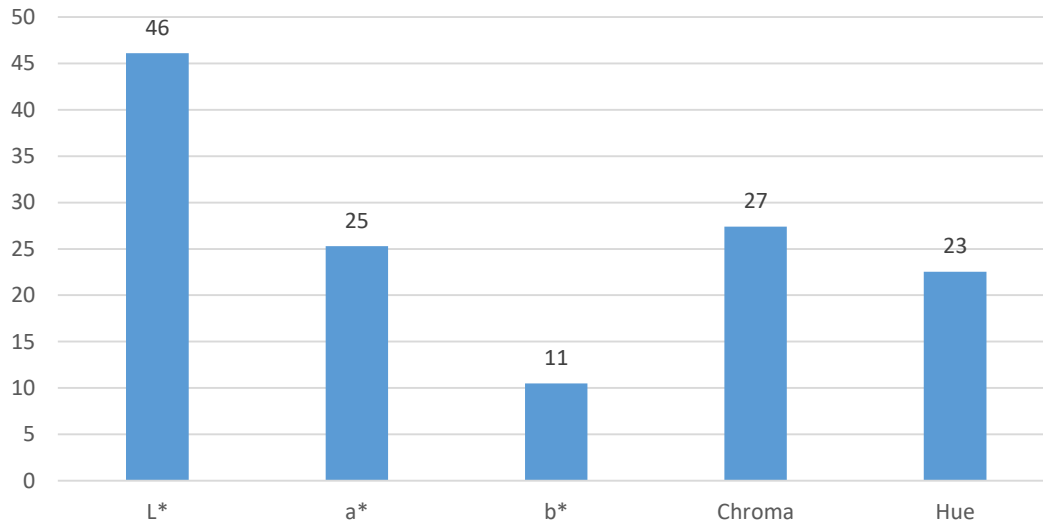
WBSf < 4,4 kg
(\varnothing cm 1,27)
is perceived by most consumers as "tender"



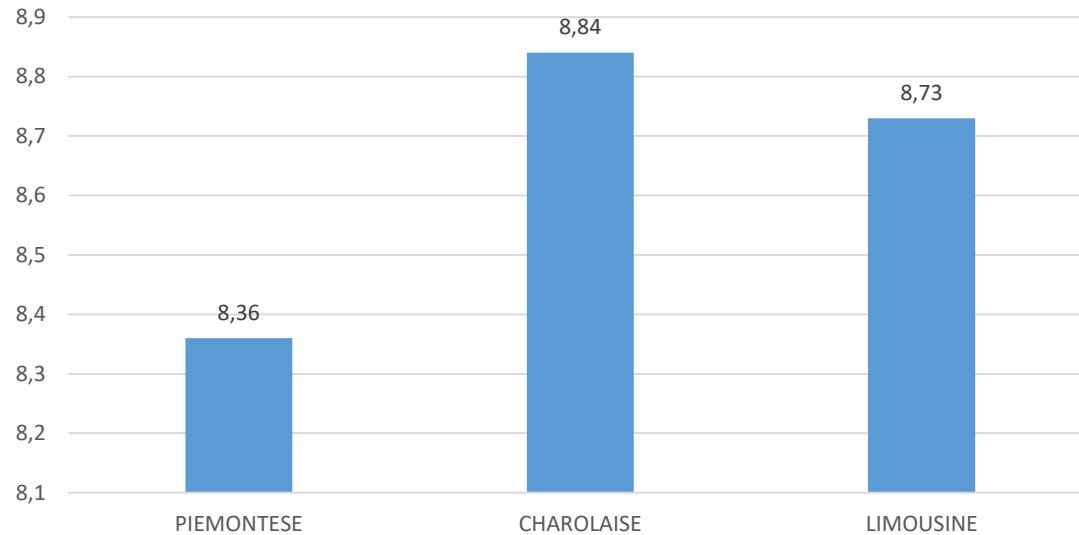
COLOUR



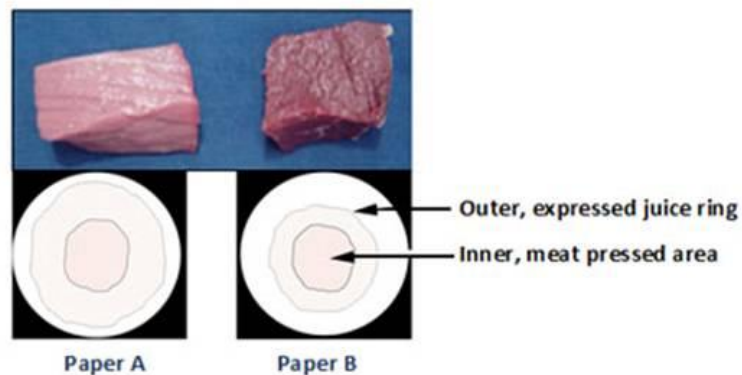
COLOUR: BLONDE D'ACQUITAINE



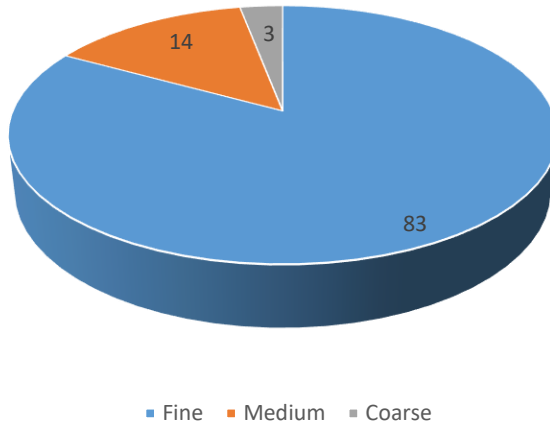
Graü & Hamm: filter paper press method (T-M; cm²)



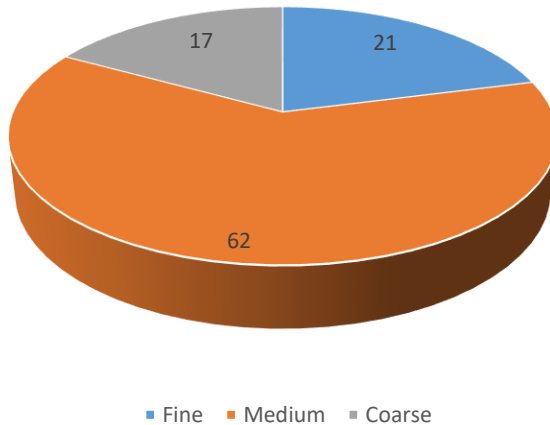
Piemontese meat had a better Water Holding Capacity



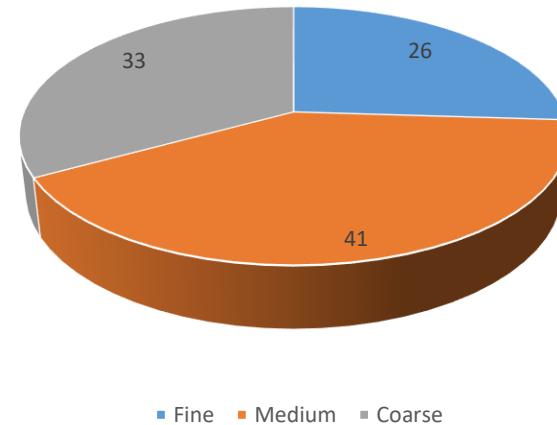
PIEMONTESE: grain (%)



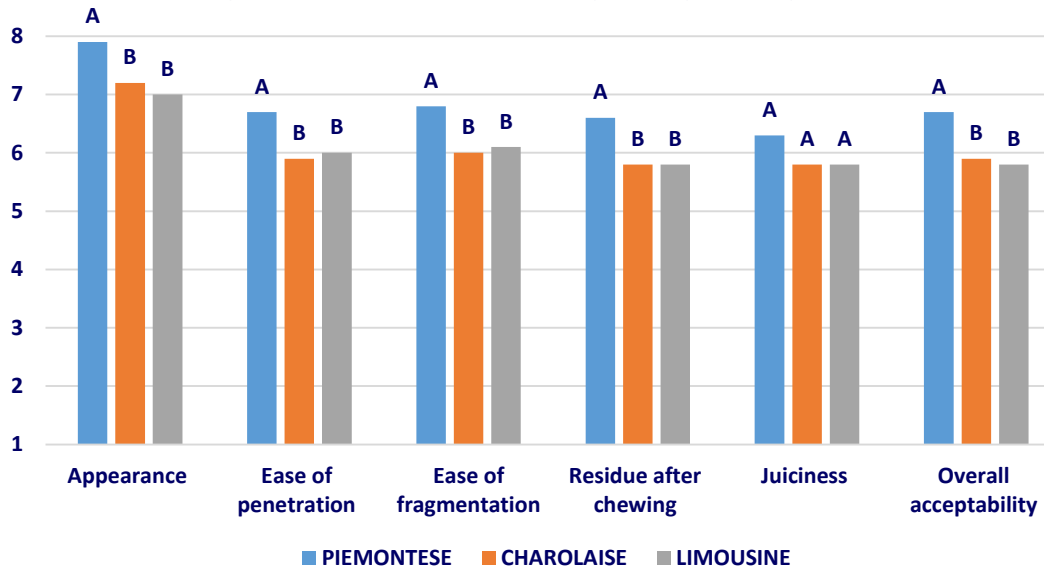
CHAROLAISE: grain (%)



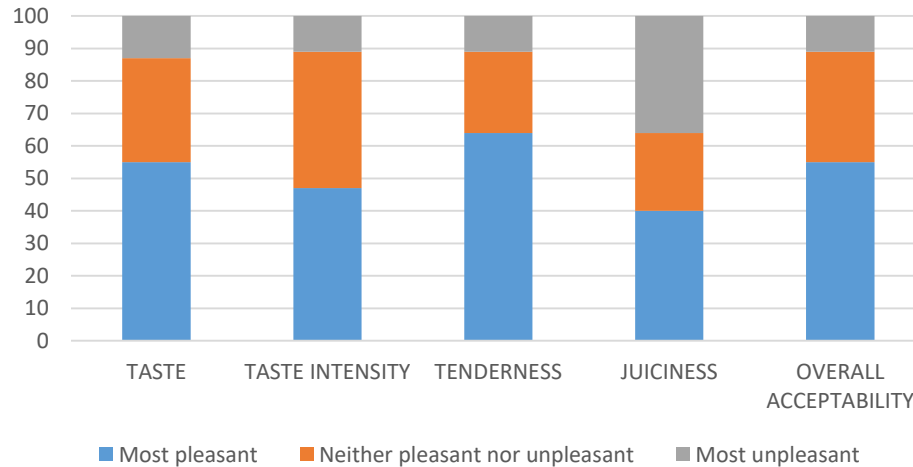
LIMOUSINE: grain (%)



Sensory scores for beef sensory analysis (8-point scale)



Consumer test: Blonde d'Aquitaine (%)







Alberto Brugiapaglia graduated with a M.Sc. degree in Agricultural Sciences with specialization in Animal Production and obtained a Ph.D. on meat sensory evaluation from the University of Torino, Italy. He performed postdoctoral research on meat quality from double-muscled cattle.

Since 1988, he has been associated with the Department of Agricultural, Forest, and Food Sciences of the University of Torino where he was promoted to assistant professor and then to associate professor.

He was among the founders of the Italian Association of Meat Tasters.

His main research interests focus on the effects of genetic and environmental factors on carcass composition and meat quality, with emphasis on meat colour and tenderness.