
Elisabetta Bernardi, Ettore Capri,
Giuseppe Pulina

THE SUSTAINABILITY OF MEAT AND CURED MEATS IN ITALY

NUTRITION ASPECT, FOOD SAFETY, ENVIRONMENTAL IMPACT,
ANIMAL WELFARE, CIRCULAR ECONOMY, NO WASTE

FrancoAngeli





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ANIMAL WELFARE, CIRCULAR ECONOMY, FIGHT AGAINST WASTE

FrancoAngeli
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THE “SUSTAINABLE MEAT” PROJECT



The consumption of meat is increasingly subject to attention and criticism principally linked to nutritional, ethical and environmental reasons. To this international debate organisations and stakeholders participate inspired by different motivations: there are animalist and/or environmentalist associations, research centres, the media, etc. In this context, at least in Italy, the point of view of meat producers has never been introduced, who should instead participate in the discussion by providing information, details and objective data useful to correct, where necessary, some positions that are on occasions prejudicial or not completely correct. With this objective, in 2012, the Sustainable Meat project was born, which in uniting the main Associations of producers, has the intent to bring to people's attention the results of the commitments of the various operators of the sector offering a point of view for a constructive and transparent confrontation, free from preconceptions and extreme positions, and driven by the desire for scientific and objective analysis. The purpose is not to convince those who for personal reasons choose not to consume meat, but to inform those who include animal proteins in their diet, conscious that a balanced consumption of meat is sustainable both for health and for the environment. Analysing the sustainability of meat and cured meats means studying, in the most objective way possible, different topics concerning both the consumer and livestock production. For this reason, the contents of this book analyse nutrition, environmental impacts, food safety and animal welfare, economic aspects and food waste.

WILL WE SAVE THE PLANET BY NOT EATING MEAT?

We have heard it repeated for years: to win the fight against climate change we must banish meat and cured meats from our tables. Yet, for however praiseworthy it is to want to contribute in stopping the ongoing climate chaos, the decision to convert to veg will not only not save the planet, but it is also a profoundly wrong message, for several reasons.

The most evident, if we consider the data on the emissions of greenhouse gases, is that the production of meat and cured meats (including the cultivation of food, breeding, and processing) is responsible for 15-18% of emissions as can be seen from the statistics published regularly by the FAO (www.fao.org/livestock-environment/en/). This leads to the consideration that it cannot be an individual choice, such as quitting meat, which can solve the problem above all if you ignore all the others responsible for the current climate crisis, like the transport and energy sectors that affect the remaining 65-70%. Reminding us of this is not a meat fan, but Professor Michael E. Mann, a climate scientist, “Distinguished Professor” of Penn State University as well as one of the authors of the famous Climate Change Report of the IPCC, the Intergovernmental Panel on Climate Change which, to date, perhaps better than anyone else, illustrates the point about the climatic upheavals in progress. Referring to the “despotic” idea of the American multinational WeWork to banish meat from all its employees, Mann reminds readers how objectively absurd it is to think of helping the climate in this way. WeWork, or rather, its billionaire CEO and founder Miguel McKelvey, not only forced his employees into this choice, that appears rather ideological than eco-sustainable, but he did it stating that this change in the menu is for example much more useful than passing to a hybrid car. An affirmation that

is inaccurate under many points of view, but also deceptive. "Fossil fuels are left out of the discussion. Accepting implicitly the idea that climate solutions are voluntary measures", explains Mann to NBC News: "They are important. But it is really frustrating for me when they say to eat less meat".

According to Professor Mann, who recently wrote another excellent book against climate negation, "The Madhouse Effect", it is much more important to reduce our dependence on fossil fuels rather than not becoming vegetarian, especially if, as WeWork does, one concentrates only on meat and cured meats without instead touching on foods that are equally impactful on the environment, nor by banishing eggs and cheese which generally have upstream breeding just like meat products.

"It is incredibly irresponsible to suggest that hybrid cars do not represent an important step in the fight against carbon emitters", emphasises the Penn State professor. Equally irresponsible is advising individuals not to eat more meat, I add, neglecting the damages which this can cause to health, especially in certain age groups. All this making the belief that the fight against climate change can be ex-

empt from precise political and economic choices.

A mistaken message also because whoever promotes it probably does not know at all the agricultural and livestock sector and therefore does not know that "there exists in reality responsible ecological ways for producing meat", as Mann emphasises. In Italy we know something about this, since (I know from direct experience) we vaunt one of the most sustainable livestock models on the planet, also thanks to the commitment made in promoting good practices. Furthermore, "if all farms all over the world would adopt good practices - concludes Mann - the percentage of carbon emitted 'from the farm to toilet' could be reduced from 18% to only 10%". Not enough, if you want to save humanity.

Passing off the veg choice as more sustainable on an environmental level, but never considering the contribution of the livestock sector in preserving landscapes, territories, traditions and cultures is one of the most superficial, inaccurate and indeed irresponsible messages of our time, which seems to have breached the common imagination. It is therefore pleasing to see how also scientists that deal seriously with the defence of the climate finally take a position against the rampant and senseless anti-meat obsession of the western world.

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INTENSIVE OR EXTENSIVE, IS THIS THE PROBLEM?

Meat has been a part of human nutrition since the dawn of human history.

For hundreds of thousands of years, hominids have based their livelihood on the products of hunting and plants grown spontaneously; subsequently the progressive reduction of hunting and gathering in favour of agricultural practices laid the foundations for the birth of agriculture. With it man has modified both his lifestyle, which from predominantly nomad became stable, and his eating habits along with the management of the environment settled. Cultivation practices are accompanied by the first forms of animal domestication, that are selected and bred to help work in the fields and to provide food, wool and leather. Nutrition becomes more and more varied, having now bread, cereals, fruit, vegetables, fish and meat.

With the passing of centuries, first the roman-barbarian influences, then the medieval, the idea of meat consumption as an essential requirement for a healthy diet are strengthened. Meat remains a longed for and desired food over time, even if with very variable consumption habits depending on historical period and social class. Given that until the 13th century the practice of an agro-silvo-pastoralism offers a diversified diet and makes meat accessible to the whole population, successively one assists to the formation of a gap between the rich and varied nutrition of the nobles in the cities, and that of the rural population where economic difficulties relegate the consumption of meat to festive occasions only. The culinary culture of the countryside is developed as a consequence, giving precedence to cereals, bread, legumes and vegetables, and devising recipes to reuse all the edible parts of the animal, minimising waste.

The scarcity of meat in the nutrition of the rural population remains constant up to the early twentieth century. In Italy, it is only

starting from the Sixties of the last century that the strong economic development increases the consumption of meat, that becomes the symbol of liberation from misery and poverty. To cope with the growth in population and food consumption an intensification of meat production is undertaken: the food industry is structured to meet the increase in demand, on farms the password becomes production efficiency. Since the Eighties, in Italy, the consumption of meat has stabilised and, on the base of a well-established food security, we are witnessing a changing sensitivity on ethical issues, such as animal welfare and the environmental impacts of farms.

In this context, current consumption on a worldwide level is to be evaluated by taking into account both global factors and data related to the various eating habits in the world. There is no doubt that the growth in world population, forecast more than 9 billion individuals in 2050, compared to over 7.5 billion currently (in 1960 it was around 3 billion), will inevitably result in a greater demand for food and in particular for animal proteins, for which an increase is foreseen of around 60%. In evaluating current global meat consumption, however it is not just the absolute value that needs reflecting on as instead the extreme difference between the average consumption per capita in various areas of the world, with values ranging from about 120 kg/year in North America to less than 40 in Asia and Africa. The context has therefore changed profoundly over the years and today's need is to guarantee food for everyone on sustainable economic and qualitative terms. It is inevitable, therefore, the crossing of these concepts with those of intensive breeding, which is probably the main object of contention of those who debate on the sustainability of livestock production.

But it is necessary to clarify what is meant by the concept of intensive: more often it tends to link the intensity of a breeding

farm to number per surface unit and animal space. This type of approach is outdated and needs a methodological update which texts of agricultural economy can offer some solutions. The intensity of a breeding farm, in fact, can be defined by basing the relationship between the direct cost of labour and the total costs, the so called "capital intensity". The lower this relationship is, so with a low incidence in the cost of labour respect to the total, the more farm can be considered intensive, that is capital-intensive; on the contrary when labour costs become a factor primary we are facing an extensive usually consisting of small family-run businesses.

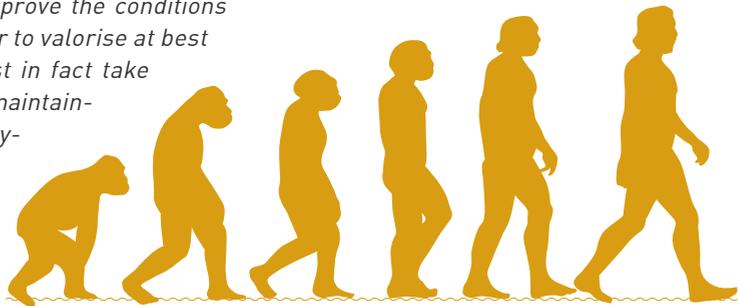
This approach is thus incoherent with the typical equation "many animals in a small space equals intensive farming". There are bovine or sheep farms, with thousands of animals, where animals have a lot of space at their disposal (think for example of the farms in Australia or Ireland), while family-owned farms have very few head confined to very restricted surfaces. Judgment on the quality of breeding should therefore not be based on the concept of the intensiveness or extensiveness of capital use in the livestock enterprise but on its objective characteristics that are a consequence of breeder's behaviour. It is more appropriate, therefore, the distinction between good and bad breeder. In the case of intensive farms, considering the economic meaning of the term, breeders have a greater availability of resources, also economic, that can (when they are good breeders) be allocated to maintain and improve the conditions of the farms. A breeder to valorise at best his farm animals must in fact take care of their welfare; maintaining a good state of psycho-physical health in animals is an indispensable requirement in guaranteeing adequate

living conditions, but it is also a crucial element to guarantee the security of the foods derived from them.

A meat of quality with the ability to achieve a higher sales price derives, in most cases, from farms "economically" intensive managed by longsighted farmers who are capable of investing in safety and food quality, on processes and farm innovation. Obviously, in all this it is also the consumer who plays an important role: if the choice of meat, and in general of food, is driven solely by the research for saving it is very difficult to guarantee adequate remuneration for the players in the supply chain, foremost the breeders. The challenge the meat sector must face today, is that of a greater "sustainable" offer that can guarantee an efficient production, attentive to the environment and the welfare of animals, breeders and all those who participate in the creation of value in Italian supply chains.

Giuseppe Pulina

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President of Carni Sostenibili Association





THE NUTRITIONAL VALUE OF MEAT

-
- 🌿 DIET AS A FOOD MODEL: THE FOOD PYRAMID
 - 🌿 THE NUTRIENTS OF MEAT
 - 🌿 THE NEEDS DURING THE DIFFERENT PHASES OF AN INDIVIDUAL'S LIFE
 - 🌿 FOOD AND HEALTH
 - 🌿 IS MEAT CONSUMPTION SUSTAINABLE?

Introduction

MEAT IS AN IMPORTANT SOURCE OF PROTEINS, OF ESSENTIAL AMINO ACIDS AND OTHER MICRONUTRIENTS USEFUL TO THE HUMAN ORGANISM

THE MEDITERRANEAN FOOD MODEL SUGGESTS A MODERATE CONSUMPTION OF MEAT

THE PER CAPITA MEAT CONSUMPTION IN ITALY IS SIGNIFICANTLY LOWER RESPECT TO OTHER DEVELOPED COUNTRIES

When it comes to nutrition it is important to start from the concept of diet understood according to the model of Greek medicine, namely a **way of life** aimed towards health, which provides indications respect to every aspect of daily life, from food, to physical exercise, till rest. Therefore, not a therapy of weight loss as a temporary remedy for an excessive consumption of food, nor based on specific diseases. Nutritional education should therefore exhort people to follow a balanced “food model”, that foresees the consumption of all foods without excessing. In this sense the **Mediterranean Diet** is of great help because the suggestions that are obtained **from this model help to consume all foods in a balanced way**, including meat and cured meats, necessary for people’s healthy nutrition.

If one enters more specifically, each food supplies **nutrients to the organism** useful to the physiology of the body. **Meat and cured meats** are for example **sources of essential proteins**, but also of many

micronutrients and **bioactive compounds** that support some special functions. Sometimes these components are more bioavailable (i.e. better assimilated) compared to plant-based sources, in some cases (for example **vitamin B12**) they are present only in foods of animal origin like meat and cured meat. It is therefore interesting to investigate the functions of the individual nutrients, relating them to the needs of the human body during the **different stages of life**.

Moving from the nutritional to the medical field one enters the area of **clinical diseases**, which in many cases can be related more or less directly to food consumption. In the case of meat, the most attention regards the alleged correlation between the consumption of meat and cured meats with some cancer pathologies. Despite the many hypotheses in this field, **the relationship between disease and moderate consumption is not currently demonstrable** and scientific studies lead to non-definitive conclusions, if not those of keeping consumption with-

in the levels suggested by most common nutritional models. It is interesting to investigate the reasons for these alleged relationships, in order to understand the possible ways to control them.

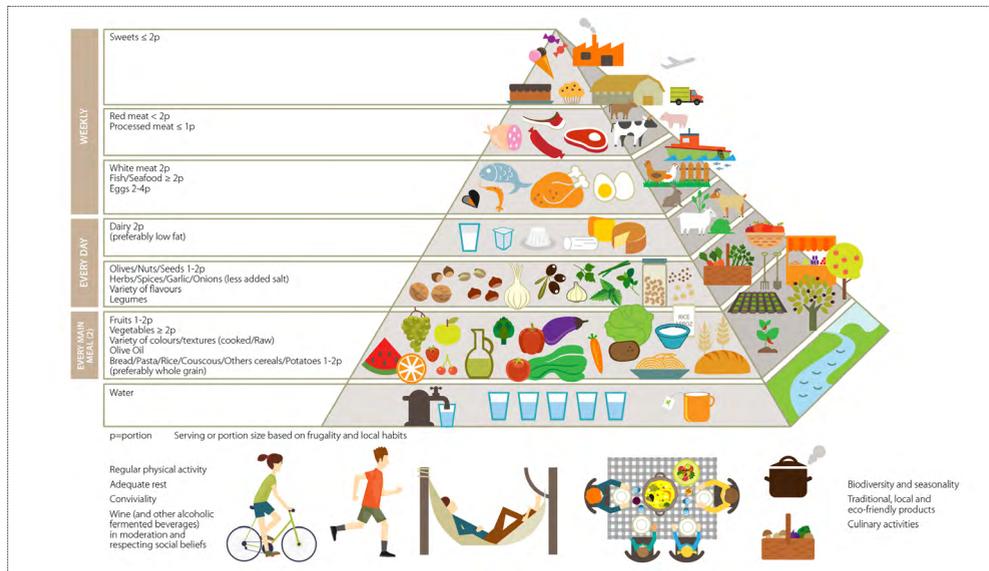
Consumption is therefore precisely a fundamental link to relate a food with its repercussions on health and sustainability in general. To the question “how much meat do you eat?” it is not easy to answer, because there is little available data and refers very often to food availability (**apparent consumption**) and not to **real consumption**. With a thorough analysis of the information available one can however draw some general considerations: the first is that the real consumption of meat and cured meats in Italy is lower than that communicated by normally used data that refers to apparent consumption; the second is that **the consumption of meat (per capita) in the world presents important differences between North American and Asian countries**.

1 DIET AS A FOOD MODEL: THE FOOD PYRAMID

The Mediterranean Diet is the result of millennia of exchanges of food and cultures between people from all the countries bordering the Mediterranean basin. This model, known to be one of the healthiest and most balanced, in the twentieth century has characterised the eating habits of the inhabitants of the Mediterranean region, originally based on agricultural and rural models.

The **Mediterranean nutritional model** foresees the **consumption of all foods**, without any exclusion and suggests a high intake of vegetables, legumes, fresh and

dried fruit, olive oil and cereals (mostly wholemeal); a moderate consumption of fish, dairy products (especially cheese and yogurt), meat and occasionally sweets. For this reason, it must be seen as **a model** in which no single nutrient or food should predominate, but the overall effect of diet. Not surprisingly, the benefits of the Mediterranean Diet are due to the synergistic combinations of the nutrients and protective substances contained in the foods, to an adequate daily intake of **energy** and **water** and the **practice of physical activity** in order to maintain a healthy physical and mental state.



The food pyramid defined by the Mediterranean Diet Foundation.
Source: IFMeD

Other strengths of the Mediterranean model are the consumption of traditional and local food products, the preference for wholemeal grains and unsaturated fats, seasonality and food biodiversity.

1.1 The food pyramid

Starting from the first definition of the Mediterranean Diet, made after the Second World War by the scientist Ancel Benjamin Keys who first highlighted how cardiovascular diseases in Italy, Spain and Crete were almost unknown compared to the disturbing levels already reached at that time in the United States, and that such a low rate was due to the different eating habits of those countries¹, many examples of graphical representation of the Mediterranean nutritional model followed. With one objective always: make communication simple and educate people. After the recognition of the same Mediterranean Diet as an Intangible Cultural Heritage of Humanity by UNESCO in 2010², and taking into consideration global interest, the Mediterranean Diet Foundation and its International Scientific Committee have developed in 2011³ a position of consensus, by presenting a new pyramid with which scientists hoped to contribute to a better adherence to this healthy nutritional model and the Mediterranean basin lifestyle.

The food pyramid shows the lifestyles to be adopted and the food consumption frequency to adhere faithfully to the Mediterranean nutritional model and maintain in this way a nutritional balance. As shown in the diagram, the base of the pyramid provides a set of skills, knowledge, rituals, symbols and traditions in the **field of agriculture, fisheries and animal hus-**

bandry, and in particular valorises the sharing of food consumption. **Eating together** is indeed one of the fundamental elements to be privileged as well as an active lifestyle, adequate rest and food-stuff consumption preferably following seasonality. The pyramid is structured so as to make obvious the frequencies of consumption, with at the base foods to be taken every day and at the apex those to be consumed weekly.

Every day we should drink at least 8-10 glasses of water, which equals 1.5-2 litres, but if the nutrition is rich in fruit and vegetables the recommended amount drops to 1.2 litres per day, i.e. 6-8 glasses, to be consumed at meals and during the day.

Climbing up the pyramid one meets the vegetables group, fruit and nuts, foods that provide fibre, vitamins, minerals and chemical compounds such as flavonoids, phytosterols, terpenes and phenols, which offer protection against oxidative processes, thus reducing the incidence of cardiovascular diseases⁴. Here can also be found cereals, which provide low glycaemic index carbohydrates, as long as you choose wholemeal often.

The consumption of fibre-rich products has been associated with a lower risk of diabetes, especially type 2, coronary heart disease and cancer, while refined grains are linked to an increased risk of diabetes, obesity, coronary heart disease and other chronic diseases⁵. **Extra-virgin olive oil** should be the predominant seasoning, because it provides a high content of oleic acid and polyphenols, which have atherogenic, antioxidant and anti-inflammatory effects⁶.

Halfway up the pyramid are milk and its derivatives such as yogurt and cheese, which provide high quality protein and

easily assimilated calcium. In addition, the lactic bacteria contained in yogurt can help improve gastrointestinal health and immune response, as well as inducing changes in intestinal flora associated with a reduction in the risk of colon cancer⁷. The upper part of the pyramid includes the group of “**protein**” foods. Foods like **meat, fish and eggs** are precious sources of high quality proteins, easily digestible and they are rich in many essential micronutrients such as **iron, zinc, vitamin A and vitamin B12**, which can contribute substantially to ensuring the adequacy of the diet, preventing any nutritional deficiencies⁸. In addition these foods contribute to a **positive impact on growth, cognitive function and physical activity, especially in children**.

This model, in addition to providing the advantages related to a high consumption of antioxidants and polyphenols, is characterised by an excellent ratio between omega-6 and omega-3 essential fatty acids. Polyunsaturated omega-3 fats (PUFA), contained in fish (for example, eicosapentaenoic and docosahexaenoic acid), regulate the haemostatic factors and provide protection against cardiac arrhythmias, cancer and hypertension⁹, and play an important role in the preservation of cognitive functions¹⁰.

Another important aspect of the Mediterranean dietary model is the reduced consumption of sodium which, when taken in high quantities, can cause disorders related to high blood pressure; the high consumption of preserved salty foods has been linked by several studies with a higher risk of stomach cancer and coronary heart disease¹¹⁻¹².

1.2 Mediterranean Diet and health

The Mediterranean Diet has been scientifically proven to improve health by increasing protection against the most common chronic diseases, such as hypertension, diabetes, obesity and cancer, reducing the onset of cardiovascular disease and preventing neurodegenerative diseases, such as Alzheimer’s and Parkinson’s. By now all the most important and influential scientific societies consider it the ideal style of diet to preserve the status of health and to reduce the occurrence of the most important chronic diseases. According to the World Health Organization, the Mediterranean Diet is one of the most promising strategies to prevent major diseases and improve the quality of life¹³.

Like traditional Asian diets, the Mediterranean Diet has also had a prominent place in the study that characterises the so-called “Blue Zones” regions, where lifestyle models, including traditional dietary approaches, have been associated with longevity and vitality¹⁴.

A study published in the British Medical Journal¹⁵ observed that a sample of over 4,000 middle-aged women, for example, showed a relationship between the Mediterranean Diet and a slowing down of the aging process. Beyond these specific quotes, one can observe how the scientific world is extremely cohesive in observing the close correlation between the beneficial effects on health and the Mediterranean nutritional model.

Inflammation is now recognised as an important factor in the development of many chronic diseases, including cardiovascular diseases, cancer, type 2 diabetes, metabolic syndrome, Alzheimer’s disease, and is also associated with obesity. The Mediterranean Diet has a preventive

effect also in this case, as demonstrated by recent studies which concluded that a low adherence to the Mediterranean Diet is associated with greater quantities of inflammatory markers¹⁶, while adopting the Mediterranean style offers greater protection against oxidative stress and inflammation and platelet aggregation¹⁷. In general, following the Mediterranean Diet means having a significant reduction in mortality from cancer, as well as a lower incidence of different types of cancer¹⁸: colorectal cancer, in particular, but also cancer of the aero digestive pathways (pharynx or oesophageal cancer) and prostate cancer.

In addition, specific food nutrients or micronutrients characteristic to the Mediterranean Diet can play a role in the prevention of breast cancer: the intake of foods containing phytosterols, vitamins C and E, beta-carotene and calcium can exert a protective action, including the reduction of cell proliferation. Consumption of substances such as ascorbic acid, carotenoids and other antioxidant vitamins is inversely related to gastric cancer and neoplasms of the upper digestive tract and respiratory tract.

The PREDIMED¹⁹ study, an international survey that assessed the effects of the Mediterranean Diet on primary prevention of cardiovascular disease, demonstrated for the first time in a randomised clinical trial that the Mediterranean nutritional model protects against cardiovascular disease and confirmed that it reduced classic and emerging cardiovascular risk factors.

An important lesson of the study is that it is never too late to change eating habits and improve cardiovascular health, and that part of the study's positive results can be attributed to extra virgin olive oil

and dried fruit and nuts, foods rich in unsaturated fats and rich in antioxidants.

Other potentially beneficial effects of the Mediterranean Diet concern a greater defence against neurodegenerative diseases and the conservation of cognitive functions, reduced inflammation, the improvement of insulin sensitivity and a possible role in the prevention of dementia and Alzheimer's disease²⁰.

In recent years, some authors have indicated that adherence to the Mediterranean nutritional model reduces the incidence of the onset of diabetes and the main protective compounds are vegetable fibres and fats such as olive oil; in particular, this protection is guaranteed by the consumption of extra virgin olive oil for cooking, seasoning, baking and frying food. It would seem that diets rich in monounsaturated fats, such as the Mediterranean Diet, improve insulin sensitivity²¹.

1.3 Portions and frequencies of consumption

Globalisation, urbanisation, changes in lifestyle and in the food chain have led to a change in eating habits and the loss of traditional food cultures. These changes, together with greater availability and marketing of products of low nutritional value, highlight the need for a coherent, simple and practical food guide to allow the population to choose a healthy diet, to prevent diseases and to guide countries in the development of policies regarding food, health and agriculture.

The guidelines for healthy eating show how you can follow a healthy, balanced diet that meets your nutritional needs. The indications are often **summarised in graphical form as a pyramid (Spain), a plate (USA) or a wheel, and vary from**

country to country depending on their cultural heritage. France has a scale with nine rules (9 Repères), Sweden has a Circle of Foods (Matcirkeln) accompanied by an ideal diet for men and women, while the United States has the dish (MyPlate); but in general the representations try to make the concept of a balanced diet easily understandable: we eat to satisfy the **need for essential nutrients such as carbohydrates, proteins, fats, vitamins, minerals, fibre, water.**

To facilitate the task of meeting the needs of essential nutrients every day, the food has been divided into groups, based on the substances they contain and give to the organism. A diet complete from a nutritional point of view, is the result of a choice of foods that, with quantities adapted to the personal needs of nutrients and energy, comes from all the food groups. Although they are coherent with the

needs of the local population, many nutritional guidelines have common rules. The majority of them promotes variety and a high consumption of plant foods as well as a reduced intake of saturated fats, salt and sugar.

The guidelines in fact give indications also on the dimensions of the portions and on their consumption frequency, but how many adhere to such indications? It is now clear that the size of the portions of food in general and those packaged in particular have increased over the last 30 years²², so much as to suggest that this is one of the factors that has contributed to the increase in obesity.

In 2014, the SINU (Italian Society of Human Nutrition) published the new LARN²³ (Levels of Reference Assumption for the Italian population) which contains, among other things, suggestions relating to the portions of each food.



GROUPS OF FOOD	FOODS	STANDARD PORTIONS (g)	PRACTICAL UNITS OF MEASUREMENT
MEAT FISH EGGS	"red" meat fresh/frozen (bovine, ovine, pork, equine)	100	1 slice, 1 hamburger, 4-5 pieces of stew, 1 sausage
	"white" meat fresh/frozen (chicken, turkey, other poultry, rabbit)	100	1 slice of chicken or turkey breast, 1 small chicken leg
	cured meats	50	3-4 medium slices of ham, 5-6 medium slices of salami or bresaola, 2 medium slices of mortadella
	fish, shellfish, fresh/frozen shellfish	150	small fish, 1 medium fillet, 3 prawns, 20 shrimps, 25 mussels, fish, molluscs, crustaceans
	fish, molluscs, preserved crustaceans	50	1 small tin of tuna in oil or brine, 4-5 thin slices of smoked salmon, ½ fillet of cod
	eggs	50	1 egg
LEGUMES	fresh or canned legumes	150	half a plate, a small box
	dry legumes	50	3-4 tablespoons
DAIRY PRODUCTS	milk	125	1 small glass, 1/2 medium cup
	yogurt	125	1 jar
	fresh cheese	100	1 small mozzarella cheese
	aged cheese	50	-

Portions of reference for protein foods.

Source: SINU (Società Italiana di Nutrizione Umana - Italian Society of Human Nutrition), 2014

MEAT IN THE MEDITERRANEAN DIET

The Mediterranean Diet has always included the consumption of animal proteins. In fact, in the Mediterranean Dietary pattern, **meat, fish, eggs and legumes** are considered part of the group of foods that provide proteins, as well as naturally the milk and derivative group. This model invites you to select a variety of protein foods to improve your intake of valuable nutrients for health. The suggestion is to limit their consumption according to **portions and frequencies that depend on age, sex and levels of physical activity**. Especially for meat, the fundamental suggestions are to prefer lean cuts and to prepare seasoning using only extra virgin olive oil, limiting sodium intake.

2 THE NUTRIENTS OF MEAT

Meat and meat products have been among the most important food products for human nutrition for centuries. The type and quantity of meat consumed have been conditioned in the past by various factors (religion, social status and supply), but there is no doubt that meat consumption has played a key role in the development of human civilisation. For example, **the development of the brain and its functionalities was only possible thanks to an omnivorous diet**, which guaranteed a lot of energy and specific nutrients²⁴ typical of meat and fish.

The human digestive system is typically omnivorous, as it has developed functionalities and enzymes useful for assimilation of animal and vegetable food. Precisely the development of the brain and the sociality connected to hunting-related practices have contributed to the evolution of intelligence, to the development of language and to the skills of planning, cooperation and socialisation.

Homo sapiens is therefore the perfect example of an **omnivorous species**. Only later did the environmental constraints, such as the need for supporting a high population density, accompanied by cultural adaptations (food restrictions and taboos, usually present in religious commandments), have transformed meat into a relatively rare food for most people in traditional agricultural societies.

A return to higher meat consumption worldwide began in Europe and North America with the acceleration of industri-

alisation and urbanisation during the second half of the nineteenth century; during the last 100-150 years, in fact, the fastest form of evolution has been recorded compared to the rest of history: **in a short time, people have reached a greater height and greater longevity**.

Not only did health care and medical knowledge improve, but nutrition also played a key role. In the second half of the nineteenth century there was still a widespread diet problem in Italy. In fact, one could observe a substantial differentiation in weight and height, depending on the economic and therefore nutritional availability (in particular the availability of meat and other noble foods): a poor man at 17 had the height of a rich man at 14; at 19 the poor man had the stature of a rich man aged 15 and the difference in height between a poor and rich 19-year-old was on average 12 cm²⁵.

In general, a balanced diet that includes both animal and vegetable foods promotes harmonic growth, **but removing any of the essential nutrients causes the body to stop growing: just only iron deficiency** during the first years of life and development can lead to reduced growth and a **reduction in the IQ of a boy in relation to his potential**.

THE ROLE OF MEAT IN THE MEDITERRANEAN DIET

A SOCIAL HISTORY OF MEAT IN ITALY

edited by Silvana Chiesa - University of Parma

The presence of meat in human nutrition has been demonstrated from the fossil evidence found in all the archaeological sites, from the Upper Palaeolithic to the Neolithic, showing that even hominids were omnivorous, that is, they alternated their diet of foods of vegetable origin with the consumption of meat. The concomitant presence of findings of broken animal bones and sharp instruments to cut the carcasses, however, does not say much about the methods of procuring meat. It seems indeed that *Homo habilis* as well as *Homo erectus* consumed both those deriving from carcasses of already dead animals (killed by other predators) as well as those obtained by hunting in groups. We know nothing about the quality and quantity of plant foods in relation to those periods, because unfortunately there are no “remains” to be subjected to chemical/physical analysis.

The arrival of *Homo sapiens* and his settling permanently in temperate areas, seems to have initially resulted in an increase in meat consumption to compensate for the periodic shortage of plant foods in adverse seasons: autumn

and winter²⁶. Later, with the constant use of fire to cook food and the gradual phasing out of hunting and gathering in favour of agricultural practices, the foundations of what has been called the “**birth of agriculture and civilisation were created**” and, from the point of view of nutrition, the fundamentals of what we call today “**Mediterranean Diet**”. By choosing to practice agriculture to produce their own food, not only humans gradually changed their **lifestyle, which from nomadic became stable**, but also profoundly changed the natural environment in which they decided to settle. To create areas to cultivate they practiced systematic deforestation, control and deviation of water courses, levelling and fencing of soil, artificial seeding, harvesting and conservation of seeds gathered and finally the transformation of seeds into food. All this work found its maximum expression in the production and consumption of a new food, that is **BREAD**, which does not exist in nature and which symbolised the abandonment of mankind’s “wild” state. If bread as a result became a symbol of civilised men, who no longer consumed what

nature gave them, but what they had invented themselves, even meat could no longer be derived from hunting alone. Meat became symbolically the product of “choice”, from the domestication and selection of some animal species. The breeding of sheep, cattle and pigs was itself a symbol of civilisation and detachment from a “wild” life, so much so that **humans decided to build fences and shelters for the animals, to defend them from wild predators, and ensure that they always had food and water available, in a word they became breeders.**

The “proximity” between men and animals (**synanthropy**) posed, perhaps for the first time, the problem of “guilt” inevitably resulting from the killing/slaughtering of animals, in particular towards the cattle considered “Ox plough” therefore a precious collaborator for mankind. Ritual sacrifices dedicated to the gods have been interpreted as a way of justifying the violent act against a synanthropic animal, and the subsequent division and consumption of meat as a moment of sharing and social recognition²⁷. In fact, men were differentiated in “partic-

ipants" and "excluded" from the sacrificial banquet, and subsequently the distribution of the meat distinguished those who were entitled to the first and more abundant portions (princeps) from those who divided the rest (populus)²⁸. Naturally from such a significant context a movement of rejection of sacrifice and the consequential consumption of meat is born and identified. Among the first that we can identify are the Orphic and Pythagorean movements which, in turn, applied strategies of cohesion and identity, refusing to participate in sacrificial rites. In the Roman world, from the Republican to the late Imperial age, there is a progressive increase in the consumption of meat, especially in the cities and among the upper classes. This can be partly justified by urban procurement policies and in part by the progressive disengagement from slaughter of religious rituality, to be incorporated into a series of rules that today we would define "hygiene and protection of public health". Even the progressive affirmation of the Christian religion freed the consumption of meat from sacrificial rites, but preserved (and sometimes strengthened) the use of celebrating the "major" religious festivals with meat banquets. The so-called "Mediterranean Diet" became questioned in its principles of identity

(bread as the main food, then porridges of cereals, vegetables, dairy products and little meat) by the establishment in Italy of the Roman-Barbaric Kingdoms (from the fifth century AD) that brought forward the cultural, economic and food values of the populations from northern Europe. These, while practicing agriculture (cultivating barley to produce beer), are represented as meat eaters, and in particular pork and/or hunted game.

The barbaric culture, which will be assimilated and elaborated in the **Italian medieval culture, considered meat as the most important source of strength and energy for mankind and in this logic it became the prerogative of great warriors, leaders and powerful people**. Even the conversion of the Barbarians to the Christian religion, in a certain sense strengthened the symbolic value of meat because penitence obliged the respect of the days of abstinence, in which the consumption of meat was forbidden (Lent, Wednesday and Friday of each week), which became fasting and assumed great importance and significance only if inserted in a strongly carnivorous culture. The same consideration can be made regarding the food choices of the origins of monasticism (5th-6th century) which considered abstention from consumption of meat an

obligation for religious men and women who, in this way, marked the difference in lifestyle between themselves and those who lived "in the world". Even **medieval medical thought** believed that the consumption of meat was necessary to restore the "health of the body" and was shared and widespread knowledge found in dietetic rules such as the Regimen sanitatis, but also in other monastic rules:

«I dare neither forbid nor allow you to eat meat because of your weakness ... Those who have sufficient strength are abstained from the meat ... Those who need physical force make use of meat; for example, those who work in mines, who fight in war, who build tall buildings or those who struggle in different jobs. / The use of meat helps recreate the forces»²⁹.

«You never eat meat. Do not distribute chickens or any other kind of birds to the community / they are to be obtained only for the sick and those of delicate health»³⁰.

The centuries therefore from the ninth to the twelfth are those of the greatest prestige for meat consumption, and represent also a period in which almost the entire population (without class distinction) is able to access this resource thanks to a defined **agro-forestry-pastoral** economy that supported, as

well as agriculture (almost entirely absorbed by the production of cereals and legumes) breeding and the exploitation of uncultivated spaces where hunting was practiced both of large prey (noble hunts) and of small mammals (peasants and villagers). The fact that almost everyone could eat meat, however, does not mean that this was the same for everyone: different “quality and quantities” for the various social classes indicate, referring to the studies of **J.L. Flandrin**³¹, how the **statute of meat**, has been defined, meaning by this term the set of **social, economic, political and cultural values that the consumption of meat represents**. If in fact from the ninth to the twelfth century the warriors, nobles and rich people consumed meat of large mammals (cattle, bears, deer, fallow deer, wild boar) and in large quantities, or at least in banquets a great abundance of meat was shown, the lower classes ate chickens, geese, rabbits, hares and especially pork, which provided meat reserves with **cured meats and sausages also for the winter**. Even the religious, and in particular the upper hierarchies of the monasteries and the major dioceses, while scrupulously respecting fasting in the days of abstinence, show intolerance towards the prohibition of consuming meat and a fine example is what

Pietro Abelardo wrote in the twelfth century:

«If the popes themselves, the guides of the Holy Church, the clergymen communities can eat meat without committing sin, because they are not bound by any vote, who could blame us for being condescending with women, especially if they endure a greater restraint than the rest?... We, therefore, considering both the possibilities of men and their nature, do not forbid any food but only excess. We wanted to adopt a measure for the use of meat: do not eat more than once per day, do not offer different portions to the same person, nor are other dishes added to it, it is not allowed to eat it more than three times a week, that is on Sundays, Tuesdays and Thursdays, even if they interpose with feast days»³².

From the 13th century onwards, a series of political and economic changes began, where the nobles, owners of the lands and forests, forbade access to the woods to villagers and peasants, who then could no longer obtain meat freely. This fact led to the radicalisation of two opposing food models, namely that of the countryside, which consumed very little meat, and that of the city in which every food (including meat) was always available and the only limit consisted of economic wealth. Even gas-

tronomy was organised on the same basis developing an urban and “bourgeois” model that focused on the cooking of meat (especially beef) as an emblem of wealth, refinement and sophisticated elegance, while rural gastronomy provided very few meat dishes, mainly pork, chicken and rabbit, and above all was characterised by an attention to the use of all the parts of the animals (muscles and viscera) and an abundance of recipes of “second processing” (from **meatballs and meatloaf** to “redone” meat) just to **avoid wasting food so rare and highly desired**.

The chronic lack of meat in rural areas in the diet of Italian populations became a constant that lasted until around the beginning of the twentieth century, and the information received unfortunately disregards any type of qualitative/quantitative surveys, relying mostly on narratives, or dramatic reports of doctors and nurses.

With the birth of the Italian nation (1861) and then with the establishment of the Institute of Statistics (ISTAT) we finally have also available numerical data which, if on the one hand in an irrefutable way confirms the paucity of meat consumption (about 11 kg/year per person), on the other does not differentiate the consumption of citizens in towns from those in rural areas³³.

That meat was anyway one of the most desired foods can be seen above all from the testimonies of Italians who, because of hunger and misery, found themselves facing a migratory adventure since the Eighties of the nineteenth century, which involving Piedmontese, Venetian, Calabrian, Sicilian, etc. The destinations were mostly Argentina, United States, Brazil and the common news was almost always the amazement about the food consumption in the countries of destination and above all for the abundance of meat and the possibility of consuming it even every day (!).

Lastly, even the Calabrian labourers that arrived in the United States were amazed by the "equality" of eating habits, and this equality consisted precisely in the fact that everyone could indiscriminately have access to the consumption of meat daily. In 1890, the results of the Inquiry into the hygienic and sanitary conditions of the workers of the earth were published in Italy by Mario Panizza (a summary of the more famous Jacini-Bertani Inquiry) which stigmatised once again the constant lack of food for rural populations with a strong emphasis on the lack of an adequate consumption of meat that was limited to religious festivals, weddings, baptisms and little else. This situation lasted until

the first third of the twentieth century; in fact, what Ancel Keys saw at the end of the Second World War in central and southern Italy was a chronic habit of not consuming meat, but what he did not see was the fact that this was not a "life choice", but rather the result of centuries of "chronic impossibility of accessing meat consumption".

The period of the **Sixties** of the twentieth century **in Italy** were years of great economic development and finally hunger was defeated as well as areas of undernourishment. The consumer food model spread and **meat, so desired for centuries, finally became available to everyone.**

Eating meat was a kind of declaration of freedom from misery and poverty. Doctors and paediatricians continued to suggest the consumption of meat as a factor to improve the growth of children and young people. The daily meat ration of military conscripts was 200 g (even today this is the daily ration as by OG), canteen meals always provided a meat dish, and throughout the next decade what was the "second course" of Italian gastronomic tradition, became almost exclusively meat (steak, slice, roast, boiled, cutlet, escalope) making them forget, for a certain period, the gastronomic variety that the traditional and poor al-

imentation had developed over the centuries.

From the Mid-Eighties of the twentieth century the attitude against the consumption of meat began to change: forgotten the initial enthusiasm, the first signs of damage due to excessive consumption of meat and animal fats were also discovered in Italy and inevitably triggered the same and opposite reaction for which the consumption of meat was considered cause of the main health problems. Partly supported by the large producers of pasta, a new model of Mediterranean Diet was re-elaborated which, taking as an example the gastronomic culture of the Mediterranean countries, proposed as a food base, bread, pasta and the use of the rich heritage of vegetables, fruit and cheeses that characterises the Mediterranean basin, bringing the consumption of meat to be a necessary complement of a balanced diet.

Since the beginning of the 21st century, meat consumption is therefore recommended in limited quantities during the week, but it is fully present in the Mediterranean Diet as it has always been for millennia.

THE CONSUMPTION OF ANIMAL PROTEINS AND THE CO-EVOLUTION OF MAN AND HIS DIET

edited by Giuseppe Pulina

Paleoanthropologists all agree that hominins, a term that recently substituted that of hominids in order to encompass all the extinct species related to *Homo*, evolved from species that were nurtured almost exclusively with unripe leaves and berries. Our ancestors, however, did not have only one food pattern, but were non-specialised frugivorous: the dental coating, in fact, although changing in the various evolutionary stages, suggests that our ancestors never turned into strict carnivores, but kept always a certain degree of vegetarianism, therefore remaining always omnivorous³⁴.

This versatility in the diet resulted in the ability of hominins to inhabit a wide variety of different food niches, even though they have a poorly developed digestive system, small teeth and weak jaws.

The comparison between the teeth of *H. sapiens* and *P. boisei* shows that the latter had to spend 6 to 8 hours a day chewing fibre-rich vegetable foods³⁵ (fig. 1). Likewise, the cranial ridge of *P. boisei* was particularly developed because the powerful maxillary muscles were attached to it, a feature that has complete-



Fig. 1 Comparison between the teeth of *Homo sapiens* and *Parantropus boisei*



Fig. 2 The cranial ridge of *P. boisei*, disappeared in modern man, indicate the presence in this hominin species of powerful masticatory muscles for the crushing of vegetables

ly disappeared in modern man (fig 2).

Modern man preserves the memory of this prevalence of vegetables in the diet with a tract of the intestine (the colon) that is responsible for the fermentation of fibre, which cannot be digested by gastric juices, of which vegetables are rich. But if today we try

to nourish ourselves with the foods selected in nature by our distant cousin, the chimpanzee, we would discover that the time dedicated to chewing is enormous (6-8 hours), that our teeth and muscles are inadequate and that fruits are too immature to please us³⁶. Among other things, as anthropologists

know well, the chimpanzees themselves, are passionate hunters, spending about 10% of their time hunting small mammals, mostly baboons, other species of monkeys and porcupines.

The introduction of food cooking, around 800,000 years ago, was certainly a fundamental turning point to make a large number of foods safe and more digestible including the meat of large animals, which men began to hunt by organising themselves into communities and therefore starting a fundamental phase of social evolution.

Why has mankind during his evolution moved his own preferences from a substantially vegetarian diet to a more diversified one that foresees a substantial contribution from foods of animal origin? One of the most reliable hypotheses is the so-called “**hungry brain**” put forward by Robert Martin in 1996. Man has a brain mass, if compared to body weight, about twice that of other mammals. This means a large constantly hungry brain that **consumes about 20% of the energy spent daily by an adult** (up to 50% in a new-born) and therefore needs to feed on foods that are highly digestible and of higher biological value than those of leaves and unripe fruits. Because the development of the intestinal mass

is inversely proportional to the quality of the foods consumed, **the reduction of the size of the intestines in favour of the development of the brain mass was only possible thanks to an overall improvement in the quality of the diet due to the introduction of foods with a high concentration of nutrients such as meat.** Thus, despite not having the dentition of a carnivore, mankind, thanks to the discovery of fire, was in the condition to consume large animals and, therefore, to organize themselves to hunt, giving life to an evolutionary advantage of the groups better organised and capable also of transmitting this prerogative orally.

According to paleoanthropologists, the Neolithic man assumed **more than 35% of total daily calories from meat and this**, translated in quantity, means more than **800 g per day, which is about 4 times the amount consumed on average by the North American population in our own time.** At the same time, cholesterol intake was twice that of the current one, but the total amount of fat was about half. The meat of the animals hunted by the Neolithic man, in fact, was characterised by a low fat content compared to body mass (less than 5%) and a very rich fat composi-

tion in polyunsaturated acid fats³⁷.

These selective pressures, environmental as well as later cultural, have made sure that the genotype of man, selected over a period of at least 2-3 million years, is that of the “saver”, that is to say **an organism accustomed to eating a protein based diet, unsaturated fats, vegetable fibres, fructose and a large quantity of secondary metabolites of plants.** Until the Neolithic, only occasionally it happened that men had large quantities of carbohydrates, which are able to trigger the mechanism of insulin response to promote the deposition of lipid reserves. This mechanism has allowed the activation of another great selective advantage that derives from the ability to accumulate fat in periods of excess energy and then mobilise it during periods of shortages. It is in fact known that the mobilisation of lipids in the phases of negative energy balance permits the maintenance of cognitive work even in conditions of food shortages, thanks to the capacity of the brain to efficiently use the ketone bodies formed as a result of the oxidation of mobilised lipids for energetic purposes.

Our evolutionary adaptation to meat consumption has had as confirmation,

in addition to cerebral and physical development (from the analysis of the archaeological finds, the adult physique in the Neolithic era was comparable to that of current professional athletes), **also an extraordinary increase in longevity of the human species compared to chimpanzees.**

Finch (2010) asserts that **longevity is the result of the adaptation of the human genotype to a diet rich in meat:** the genes involved, in fact, are those of resistance to inflammation and parasites, but also coding for longevity. The result was that the current Neolithic populations (with cultures at pre-agricultural stages) are hunters and include in their diet a quota >50% of proteins of animal origin. In vast areas of the planet the

only agricultural practice is breeding. Populations such as the Inuit, the Masai, the Lapps, the Andes Indio's and the Himalayan natives survive a totally hostile environment thanks to the interface with animals, usually ruminant herbivores, who explore feeding niches absolutely useless to humans. These peoples derive more than 90% of their daily energy requirements from animal products, without showing the slightest sign of the diseases that afflict us Westerners. It was the forced "modernisation" of their diet, vice versa, which led to severe metabolic disorders and in extreme cases to the total disruption and the loss of traditional cultures.

Agriculture has only recently intervened in human history: in the face of an evolution that began about 4 million

years ago, **the processes of domestication of plants and animals began only 10,000 years ago. Over 70% of daily ingested calories by modern humans derive from food** (especially simple sugars, starches, milk and alcohol) **that simply did not exist for the Neolithic man.** To this is added that about 50% of the total calories of our diet are made by only three types of cereals (rice, wheat and maize).

Furthermore, modern man gets 90% of animal origin food from only 14 of the over 40 species of bred animals and of this 90% the majority is taken from only 5 species (cattle, sheep, goats, pigs and poultry). In fact, agriculture over time has greatly reduced the nutritional multiplicity to which man had access in his pre-agricultural evolutionary path. Of the approximately 300,000 generations who have made us what we are, only 400 have known agriculture, too few for an overall adaptation of our genome to this artificial food niche.



2.1 The fundamental nutrients of meat and cured meats

The positive nutritional value of meat and cured meats can be summarised in two fundamental aspects: on the one hand, the presence of **proteins (complete as a composition in essential amino acids)**, on the other hand the high concentration of micro-nutrients always considered essential for human growth and development. Many of the **micronutrients** supplied by meat are involved in processes of **regulation of energy metabolism**. A further very important feature is the simultaneous presence of many of these micronutrients that can be of great importance: **vitamin**

A (present in large quantity in offal) and **riboflavin** are, for example, both necessary for **iron mobilisation and haemoglobin synthesis** to the point that the sole administration of iron cannot successfully treat anaemia, if these other nutrients are lacking. Protein-energy malnutrition, sideropenic anaemia and vitamin A deficiency can be avoided if sufficient quantities of meat are consumed.

Many of the nutrients of meat are obviously also found in foods of plant origin, although in some cases plant nutrients have less bioavailability, or are absorbed to a lesser extent by the body and used by cells. When comparing the strengths

DIET COMPARISON BASED ON MEAT AND VEGETABLES



VEGAN AND VEGETARIAN DIETS

ADVANTAGES

- High fibre content
- Generally lower energy content
- Ingestion of superior antioxidants

DISADVANTAGES

- Less bioavailability of iron
- Risk of vitamin B12 and zinc deficiency
- Risk of lack of EPA + DHA sources
- Proteins of lower biological value



MEAT CONSUMPTION

ADVANTAGES

- High nutritional density
- Proteins of high biological value
- Best source of iron, zinc and complex vitamin B groups, in particular B12

DISADVANTAGES

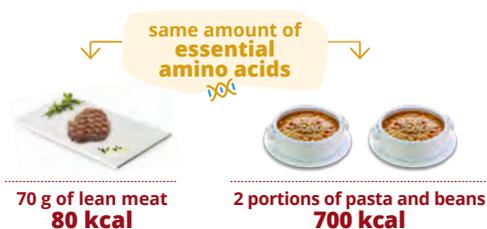
- High fat/saturated fat content in some cuts
- Sodium content (cured meats)

Source: Pereira P.M., Vicente A.F., 2013

and weaknesses of **vegetarian diets and meat consumption**³⁸, it is evident that only the **presence of both in the nutrition** of an individual can effectively contribute to a **healthy and well balanced diet**. To obtain, for example, the adequate amount of essential amino acids from an exclusively plant diet, you risk introducing at the same time an excessive amount of other nutrients compared to the needs of your body.

The combination of cereals and legumes is often referred to as an appropriate substitute for meat because of its protein intake, as the deficiencies of essential amino acids in cereals are covered by those of legumes and vice versa.

But to get the same protein quality of amino acids contained in 70 grams of meat, a small slice that bring less than 80 kcal, one would have to consume 2 portions of pasta and beans, with a contribution of over 700 kcal.



	KCAL	PROTEIN (g)	FAT (g)	CHOLESTEROL (mg)	SAFA (g)	MUFA (g)	PUFA (g)	VITAMIN B12 (µg)	IRON (mg)	ZINC (mg)
Beef front cuts	145	20.5	7	66	2.20	2.27	1.55	2.00	1.30	4.47
Beef rear cuts	117	21.5	3.4	60	1.14	1.12	0.68	2.00	1.60	3.30
Veal lean meat	92	20.7	1	70	0.42	0.48	0.04	2.00	1.20	2.80
Pork, fat meat, without fat	268	17.2	22.1	88	7.81	8.64	3.44	1.00	1.40	1.80
Pork, semi-fat meat, without fat	141	19.9	6.8	61	2.17	2.31	1.77	1.00	1.70	1.80
National raw ham*	235	27.8	13.7	75	4.84	6.35	1.89	0.38	0.80	2.10
Baked ham*	138	15.7	7.6	49	3.20	3.52	0.50	0.09	0.50	1.10
Whole chicken with skin	171	19	10.6	93	3.27	4.12	2.29	TR	0.60	1.10
Whole chicken without skin	110	19.4	3.6	75	1.23	1.08	0.81	1.00	0.70	1.30
Whole turkey with skin	135	18.2	6.9	195	2.22	1.66	2.96	2.00	0.90	2.80
Whole turkey without skin	109	21.9	2.4	63	0.90	0.62	0.60	2.00	1.00	2.70

*The nutritional composition of the meat and its micronutrients varies according to the animal species and the different types of cut. Data from the Bank of Food Composition Data for Epidemiological Studies (BDA) or *INRAN food composition tables containing 100 g of food*

Obviously not all types and cuts of meat have the same characteristics. Muscle portions are richer in essential amino acids (with greater biological value and more digestible) than connective tissues; the amount of fat (especially saturated) varies from species to species and so on.

Proteins: the bricks of our organism

Proteins are essential nutrients, as they provide the amino acids used by our body to synthesize the proteins necessary for the different vital roles:

- **structural** (skeleton, skin, tissues and supporting tissues, cells)
- **protective** (barriers, immune system, anti-inflammatory)
- **transport and communication** (plasma proteins, hormones, membrane receptors)
- **enzymatic** (digestion, metabolism, homeostasis, synthesis)
- **energy** (energy source)

The **amino acids necessary** for the synthesis of proteins useful to humans are 20, but they are not all the same: **9** of these **are considered essential**, because the body is **not able to produce them and must necessarily be ingested with food**. Furthermore, it is essential to remember that every protein synthesized by the body has its own specific amino acid composition and when it needs to be synthesized it needs the presence of all the amino acids that compose it: if even just one of these is deficient, protein synthesis is limited. In reality there is no specific food requirements for proteins, but these must be taken in such a way as to provide in sufficient quantity all the amino acids necessary for synthesis by the body. **In children semi-essential amino acids** are also considered **cysteine, taurine, tyrosine and arginine**, since synthesis mechanisms are not yet fully developed.

On the basis of the amino acid characterisation of proteins it is therefore possible to identify which foods have proteins of high biological value, and are therefore capable of supplying all the essential amino acids. It is said that a food has proteins of high biological value when it provides all the amino acids mentioned that we need, even those that we are unable to produce, and in the right quantities. And not all achieve this! Only meat, fish, eggs and milk have proteins of high biological value.

Among the essential amino acids, **methionine** plays a fundamental role in the growth of the individual.

The proteins of the vegetables are generally poor in sulphur amino acids such as methionine, on average 0.6g/100g of protein, while red meat, poultry meat and fish contain between 1 and 1.26g of sulphur amino acids/100g of protein. More gen-

ESSENTIAL AMINO ACIDS	NON-ESSENTIAL AMINO ACIDS
Phenylalanine	Aspartic acid
Isoleucine	Glutamic acid
Histidine	Alanine
Leucine	Arginine
Lysine	Asparagine
Methionine	Cysteine
Threonine	Glycine
Tryptophan	Proline
Valine	Serine
	Tyrosine

Essential amino acids and non-essential amino acids: essential ones must necessarily be assumed through food, because the human organism is not able to produce them

erally, vegetable proteins are considered of lower quality because they are **unbalanced in the ratio between cysteine and methionine** necessary for growth, which should be in favour of methionine. Considering the total of amino acids containing sulphur, red meat, poultry meat and fish have 30-40% of cysteine and 60-70% of methionine, while soybeans, beans, peas and lentils have 60% **cysteine** and 40% **methionine**³⁹.

Another method of protein evaluation recently developed by the scientific world is the DIAAS (Digestible Indispensable Amino Acid Score), which defines with a numerical index the protein quality of some foods: the higher the value, the better is the protein quality.

If it is therefore clear that the nutritional value of animal proteins is high, it is also interesting to evaluate the protein content respect to the portions suggested by the new LARN⁴⁰ and compared to caloric intake. **Fish and meat have the high-**

FOOD OR PROTEIN ISOLATES	VALUE OF DIAAS
Whole milk	139
Beef	131
Whey protein isolate	125
Soy isolate	102
Chickpeas	66
Peas	64
Rice	64
Corn	52
Barley	51
Wheat	43

Protein value index of foods.

Source: Caballero B., Finglas P.M., Toldrà F., 2015. Encyclopaedia of Food and Health. Academic Press

AMINO ACIDS (g PER 100g OF PROTEINS)	RAW HAM	BEEF TENDERLOIN	SEA BREAM BRED (FILLET)	WHOLE COW'S MILK	WHOLE EGG	FRESH BORLOTTI BEANS	PASTA
Phenylalanine	4.02	3.84	7.66	5.03	5.34	5.89	4.97
Isoleucine	5.18	4.13	4.33	5.49	5.30	5.45	4.17
Histidine	3.61	3.69	2.37	2.66	2.40	2.97	2.07
Leucine	8.31	8.02	7.58	10.14	8.40	8.68	7.65
Lysine	8.62	8.62	9.89	7.77	7.10	7.00	2.01
Methionine	2.51	2.77	3.88	2.31	3.53	1.18	1.68
Threonine	4.53	3.93	4.37	4.69	5.03	4.20	2.88
Tryptophan	1.05	1.04	1.29	1.43	1.59	1.11	0.96
Valine	5.27	4.49	4.82	6.66	6.63	6.04	4.99

Composition of amino acids of some foods (grams per 100g of protein).

Source: Food Composition Tables - INRAN, Rev. 2000

est caloric protein efficiency (Proteins/Kcal*100), meaning that per portion they have a higher quota of excellent quality proteins, but with a reduced caloric intake: a **notable advantage in terms of overweight and obesity prevention**.

Proteins of plant origin are often associated with a reduced content of saturated fats and are therefore recommended as an alternative to proteins of animal origin. But **if we wanted to cover our protein needs only with foods of plant origin,**

we would have to take **3 to 5 times more calories than the calories obtained with foods of animal origin**, in particular from lean cuts of meat or fish. The protein requirements for an individual have however been defined by the experts (LARN) in the daily amount of 0.9 g per body weight (e.g. a 70 kg adult man needs a protein intake of 63 g per day). But it is also important to remember that 100 g of meat are sufficient, which provide an average of 22-25 g of high biological value proteins, to cover more than 1/3 of the daily requirement.

FOOD	PORTIONS (g)	PROTEINS (g)	KCAL	ENERGY PROTEIN EFFICIENCY
Fish, molluscs, crustaceans (bream)	150	29.70	141	21
Meat (bovine fillet)	100	20.70	107	19
Preserved meat (raw ham)	50	13.90	117	12
Eggs	50	6.20	64	10
Seasoned cheese (parmesan)	50	16.75	193	9
Fresh or canned vegetables (borlotti beans)	150	15.30	199	8
Fresh cheese (mozzarella)	100	18.70	253	7
Dried legumes (borlotti beans)	50	10.10	145	7
Yogurt	125	4.75	82	6
Milk	125*	4.12	80	5
Pasta	80	8.72	282	3
Corn	80	7.36	282	3
Bread	50	4.30	144	3
Rice	80	5.36	265	2

* The milk portion is expressed in ml.

Protein, energy and protein energy efficiency per portion of some foods

Source: data processing Food Composition Tables - Add 2000 - INRAN *Rev. 2013

Fats: an important source of energy, but without exaggerating

According to the main nutritional indications, fats should cover **between 25 and 35%** of the total energy consumed by an individual because, if ingested in appropriate quantities, they play a number of important roles: they supply **essential fatty acids (such as linoleic and alpha-linoleic acid) and fat-soluble vitamins (A, D, E and K)**; they represent one of the main sources of energy; **promote a sense of satiety** due to the effects on the slowing of gastric emptying and reduce, for the same reason, the bioavailability of carbohydrates (and, therefore, the glycaemic response); finally, they improve the taste, smell, and consistency of foods. But all fats are high in calories. If you take more calories than necessary, you gain weight. The World Health Organization estimates that excess weight is responsible for 21% of cases of ischemic heart disease, 23% of ischemic stroke, 58% of type 2 diabetes and 39% of cases of hypertension. Obesity also increases the risk of some types of cancer, as well the risk of non-fatal diseases, such as joint problems and infertility⁴¹.

Saturated and unsaturated fats, stearic acid, no effect on total cholesterol and LDL

Saturated and unsaturated fats are differentiated by the composition of their molecule: a saturated fat has single chemical bonds between the atoms that compose it, while unsaturated fat has at least one double bond. It is this double bond that makes it unsaturated, not complete, because there is a possibility to add hydrogen to the double bond and make it saturated, i.e. devoid of space for new additions. **Liquid fats** are composed mostly of **unsaturated fats, such as olive oil**

which is monounsaturated (i.e., has only one double bond) and **solid ones (margarine, butter or palm oil, for example) are mostly saturated**. Fats are found both in plant-based foods and in foods of animal origin. Apart from some exceptions, such as tropical oils (palm and coconut), vegetable fats are mostly unsaturated, while those of animal origin are composed of about half of saturated fatty acids.

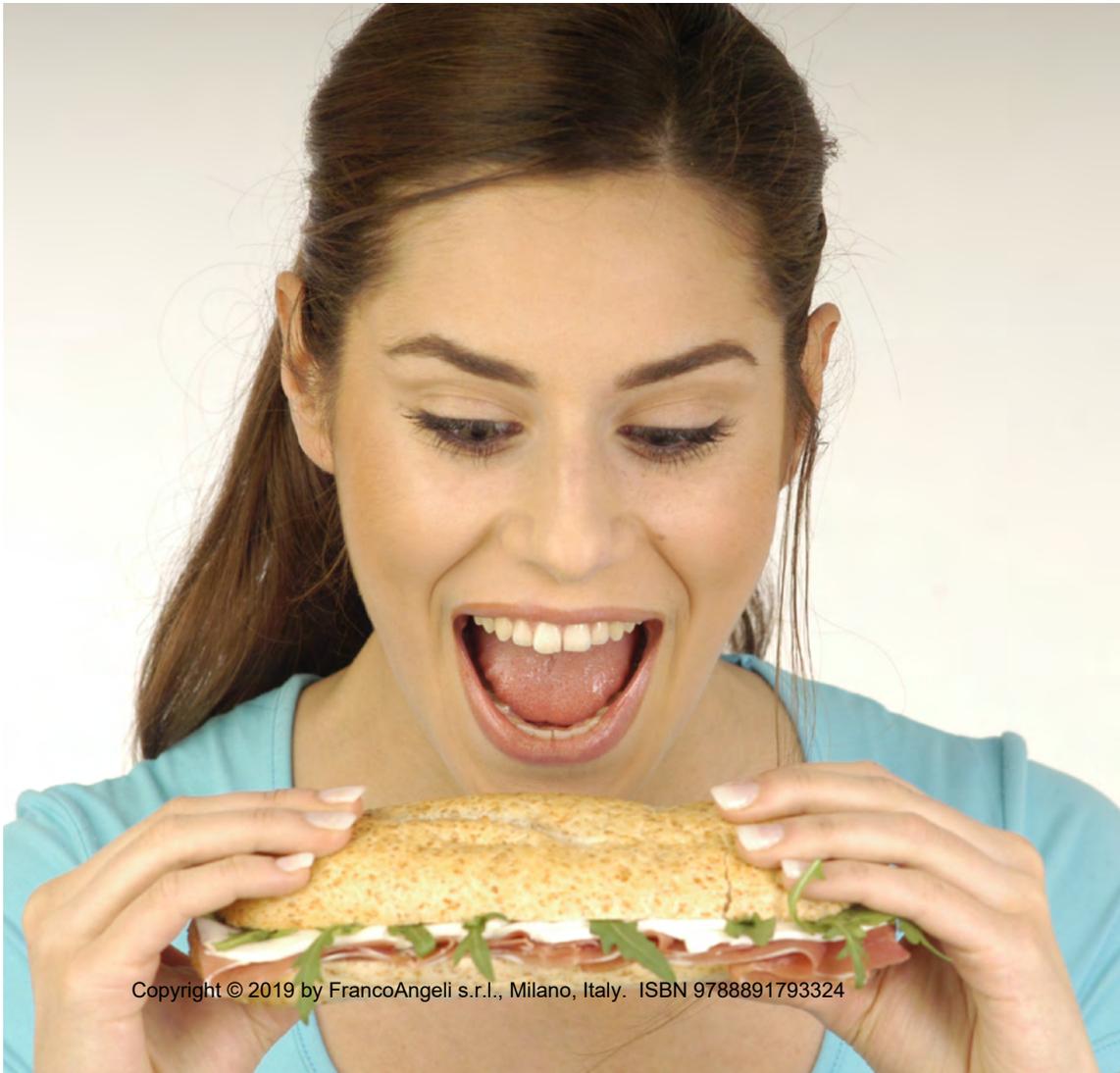
For several decades, dietary guidelines have recommended reducing the consumption of saturated fats, believed to be among those responsible for certain cardiovascular diseases, thus leading to significant reduction in the consumption of animal products, especially meat. It should be remembered that saturated fats are not all the same, because some contribute more than others to cardiovascular risks, in addition to considering the increasing evidence of the role of carbohydrates for this pathology. Recently, the PURE⁴² study, a study involving more than 135,000 people on 5 continents, concludes that a high carbohydrate intake is associated with increased mortality.

In contrast, a **higher intake of saturated and unsaturated fats has been reported as associated with a lower total mortality**. The authors observe that saturated fats do not necessarily need to be limited. The healthiest diet should include no more than 50-55% of the calories derived from carbohydrates and no more than 35% from fat, including both saturated and unsaturated. In practice, according to the study, there is no evidence that taking less than 10% of energy from saturated fats is beneficial, but going below 7% can be dangerous. The right amount of saturated fats should be around 10 to 13%. In addition, the largest constituent of saturated meat fats, **stearic acid, has been**

shown to have a neutral effect on cholesterol and LDL totals (low-density lipoprotein).

Growing attention to the quantity and quality of fats contained in meat has led producers and **breeders to study productive practices** (cutting techniques) and **breeding** (animal diets), in order to **produce generally leaner meats** and also to favour an ever more balanced fat composition. Cooking can have a great influence

on the meat fat content, as well as in the composition of fatty acids. Some authors have shown significant reductions in the amount of fat in different cuts of meat that are grilled or pan-fried without added fats. In particular, as regards to the fatty acid composition, there has been an increase in the polyunsaturated/saturated ratio, probably because polyunsaturated fatty acids are part of the cell membrane and therefore tend to remain in the meat fibres.



FOOD	FATS (g)	OF WHICH SATURATED (g)	OF WHICH SATURATED (%)
Parmesan cheese (50 g)*	14.05	9.27	66%
Salami (50 g)*	19.15	7.24	38%
Milk chocolate (30 g)*	11.28	6.75	60%
Croissant, brioches (50 g)*	9.15	5.10	56%
Butter (10 g)	8.34	4.87	58%
Palm oil (10 g)	10.00	4.71	47%
Sponge cake type snacks (50 g)*	11.15	4.70	42%
Margarine (10 g)*	8.28	4.25	51%
Shortbread biscuits (40 g)*	8.40	4.18	50%
Pork steak (100 g)	8.00	3.66	46%
Whole chicken with skin (100 g)	10.60	3.27	31%
Cheese crackers (30 g)*	7.65	2.83	37%
Raw ham (50 g)	6.85	2.42	35%
Beef front cuts (100 g)	7.00	2.2	31%
Peanut oil (10 g)*	10.00	1.93	19%
Egg (one egg 61 g) *	5.30	1.93	36%
Baked ham (50 g)	3.80	1.60	42%
Extra virgin olive oil (10 g)	10.00	1.44	14%
Whole chicken without skin (100 g)	3.60	1.23	34%
Beef rear cuts (100 g)	3.40	1.14	34%
Veal fillet (100 g)	2.70	1.14	42%
Cocoa and hazelnut cream (10 g)*	3.24	0.99	31%

Fat content of some of the main foods

Source: Food Composition Tables - Research Centre for Food and Nutrition;

** Source Food Composition Database for Epidemiological Studies in Italy - BDA-IEO*

MEAT IS INCREASINGLY LEAN

It is estimated that in the United States alone the total quantity of fats in products derived from cattle has decreased by 44% since 1970⁴³. Even in Italy meat is noticeably “slenderised”. If you compare data from food composition tables (INRAN - National Institute of Research for Foods and Nutrition) related to 1996 and 2005, it turns out that fats in **beef tenderloin** has gone **from 5% to 2.2% (-56%)**, those of loin from 5.2% to 2.9% (-44%). A reduction that affected all beef cuts, also those of pork and cured meats. The new nutritional values of Italian cured meats emerging from the analyses carried out by INRAN and

ASSICA (Experimental Station for the Food Preservation Industry) in 2011, confirm that cured meats are even more nutritious than in the past and have a better nutritional profile, because of less fat, with less cholesterol, salt and preservatives and more proteins, vitamins, minerals and essential fatty acids.

Pork meat from the Eighties has reduced its fat content by about 30%, also in order to meet the wishes of consumers. The loin is the leanest part of both beef and pork, while the breast is generally the leanest part of poultry meat. The skin is the main source of fat in poultry meat. The fat content in the major

retail cuts of the poultry ranges from 1 to 17%, and the cuts containing the skin have the highest values. In particular, the energy value of poultry meat varies between chicken breast and chicken thighs with skin: the presence of the skin (due to its fat content) increases the caloric value by about 25-30%. Fats, mainly found in the skin, can therefore be easily removed. The lipid content of chicken and turkey is about 1% in leaner cuts, such as chicken and turkey breast, and about 17% in chicken wings cooked with skin. However, compared to other types of meat, poultry appears to be relatively low in fat.

BEEF 	FAT (%)		REDUCTION
	1996	2007	
Round steak	2.8	1.1	-61%
Fillet steak	5.0	2.2	-56%
Sirloin steak	5.2	2.9	-44%

PORK 	FAT (%)		REDUCTION
	1993	2011	
Baked ham	14.7	7.6	-49%
Raw ham - San Daniele PGI	23.0	18.6	-19%
Mortadella	28.1	25.0	-11%

Comparison of the reduction of lipids contained in meat

Cholesterol: new research completely rehabilitates meat

To determine the nutritional value of meat it is best to consider also the cholesterol content, which in red meat is between 49 and 88 mg/100 g, while in poultry it is between 63 and 95 mg/100 g.

Lean meat has a low energy value which, in an appropriate diet, also reduces the concentration of plasma lipids, as indicated by several authors. For example, one study assessed how **lean beef and skinless chicken** have similar effects on plasma lipoproteins and how **they are interchangeable in cholesterol-lowering diets**.

In a similar research, other authors have compared the effect of lean red meat and lean white meat. **In the long experiment, which lasted 36 weeks, diets with one of the two types of meat reduced the level of LDL cholesterol and increased the level of good HDL cholesterol in the plasma⁴⁴.**

The use of meat in diets to lower the level of cholesterol in the blood is only valid for lean meat.

Vitamins and Minerals: essential micronutrients for metabolic functions

Meat is an excellent source of different vitamins and minerals, fundamental micronutrients present in biochemical forms that make them easily digestible. About 25% of the recommended daily allowance is covered with 100 grams of red meat (RDA) for **riboflavin, niacin, vitamin B6 and pantothenic acid and two thirds for vitamin B12**.

Chicken breast is a particularly good source of niacin (100 g provides 56% of the RDA) and vitamin B6 (27%), while 100 g of turkey breast provide 31% of niacin and 29% of vitamin B6. Meat is also one of the best sources of **zinc, selenium, phosphorus and iron**: the lean cuts of beef provide

NUTRIENTS	RECOMMENDED DAILY ALLOWANCE (RDA) ⁴⁵	BEEF	VEAL	PORK
Thiamine (mg)	1.1	source of	-	rich in
Niacin (mg)	16	rich in	rich in	rich in
Vitamin B12 (µg)	2.5	rich in	rich in	rich in
Vitamin D (µg)	5	-	source of	-
Iron (mg)	14	-	source of	-
Selenium (mg)	55	-	-	source of
Zinc (mg)	10	rich in	rich in	rich in
Potassium (mg)	2000	source of	source of	source of

Micronutrient content of red meat, classified as a source of or rich in (EC REGULATION No. 1924/2006 on nutrition and health claims given on foodstuffs)

about 37% of the reference intake of selenium, 26% of zinc and 20% of potassium in a 100g portion.

Lean red meat contains a number of vitamins and minerals that are important for all stages of life. For some of these nutrients, the meat could be defined as⁴⁶ “**source of**” or “**rich in**”, using the evaluation of the European Union, which is based on the recommended daily allowance (RDA). Food can be defined as “**source of**” if it contains $\geq 15\%$ of the RDA per 100g for a particular vitamin or mineral, or as “**rich in**” if it contains $\geq 30\%$ of the RDA.

An iron mine

Iron plays a crucial role in maintaining health, since one of its deficiencies is connected to the malfunction of different biological mechanisms of the organism, as well as disturbances in the growth of a child and during development. Taking into account physiological losses through

the skin, intestines, urinary tract, airways and menstruation in women, diet plays a key role in maintaining the balance of iron.

Heme iron and non-heme

Iron can be found in a wide variety of foods, but it is essential to note that it can take two different forms: **heme iron** e **non-heme iron**. The substantial difference concerns the greater ease of assimilation of the heme form: **the bioavailability of heme iron is greater than 15%** and is absorbed at enterocyte level as an intact molecule, while the absorption of **non-heme iron** is linked to other components of the diet, which can increase or reduce absorption, and is estimated at around 5%.

In fact, the assimilation of iron by the human organism can be facilitated or inhibited depending on which other components are present in foods. An example is

VITAMIN B12

Meat and cured meats bring to our body a significant amount of **vitamin B12**, important for various functions of the body especially with **regards to red blood cells**. It is in fact involved in the synthesis of haemoglobin, where it acts in combination with folic acid in the formation of blood cells.

Vitamin B12 deficiency is the main cause of megaloblastic anaemia and is strongly associated with high levels of homocysteine in the blood, which is a **risk factor for cardiovascular disease**. It can also **cause depressive symptoms and neurological disorders**. In children, vitamin B12 deficiency may be a risk factor for **neural tube defects**.

Vitamin B12 is found exclusively in foods of animal origin, mainly in liver, kidneys, meat, fish, eggs, milk, clams; however, it can also be found in some types of algae. For **people who follow diets without food of animal origin**, with a complete abolition of meat, fish, eggs and milk, it is essential to **use vitamin B12 supplements** to avoid the development of hypovitaminosis. The situation is to be monitored also for **vegetarians who, while eating some products of animal origin (eggs and dairy products), do not get enough**.



given by the role of **meat proteins, which contribute to an increase in the absorption of iron and zinc from other food sources.**

The sources of **vegetable iron**, on the other hand, are particularly **rich in potential inhibitors of iron absorption, such as phytates**, and of some phenolic compounds such as polymerised flavans, which are found in legumes such as beans

and broad beans. Legumes are also an important source of non-digestible carbohydrates, which can compromise iron absorption. Although **ascorbic acid (vitamin C) can improve the absorption of non-heme iron.**

Heme iron is present in haemoglobin and in myoglobin, so it is present only in some foods of animal origin. In particular

		 RAW MEAT		 COOKED MEAT	
		IRON TOTAL	HEME IRON	IRON TOTAL	HEME IRON
CHICKEN	Breast	0.40	0.12	0.58	0.16
	Thigh	0.70	0.20	1.34	0.30
TURKEY	Breast	0.50	0.14	0.70	0.21
	Thigh	0.99	0.49	1.46	0.57
ADULT BOVINE	Sirloin	2.07	1.72	3.59	2.64
	Fillet steak	2.35	2.11	3.36	2.86
	Roastbeef	2.04	1.77	3.74	3.14
	Topside	1.93	1.68	2.88	1.89
VEAL	Filet	0.85	0.71	1.58	1.33
LAMB	Cutlet	2.23	1.68	3.20	2.25
HORSE	Filet	2.21	1.75	3.03	2.16
OSTRICH	Filet	2.43	1.76	3.78	2.85
RABBIT	-	0.45	0.25	0.60	0.31
PORK	Loin	0.36	0.20	0.46	0.21
	Steak	0.49	0.32	0.79	0.56

Total iron and heme iron content in raw and cooked meat (mg / 100 g) (Lombardi-Boccia et al., 2002)

meat is the best source of heme iron, because more than half of the iron in meat is of the heme type. The adult bovine has the highest content of heme iron, the loin contains about 77%. Both heme and non-heme iron is present in much lower quantities in poultry meat. The dark parts, like the thigh, contain them in slightly larger amounts. Pork meat, defined as red meat, may contain the same amount or even less iron than the chicken or turkey thigh, which fall into the so-called white meat. From the examination of the data it is deduced, moreover, how the iron content in the meat of different animal species depends on the use of the muscle by the animal itself. It is evident, therefore, that the classification of meat as generally defined has a limited importance from the nutritional point of view and that it would be much more informative to use the adjective referring to the species of belonging (beef, pork, poultry, sheep, etc.).

Meat and meat products can contribute **up to 18%** of the daily iron requirement, an important contribution to a healthy and balanced diet that is fundamental in preventing one of the most common nutritional deficiencies.

Despite its vital role in the human body, an excessive dose of iron can be dangerous. High doses of iron can cause damage to the intestinal mucosa and lead to systemic toxicity. This excess can also induce damage from the free radicals to different tissues, and recently several studies have associated very high doses of iron to an increased risk of colorectal cancer, cardiovascular disease, infections, neurodegenerative diseases and inflammation. The maximum level of **iron** intake in order to avoid negative health effects in **adults equals 50 mg/day⁴⁷: the amount contained in two kilos and a half of beef!**

Bioactive compounds of meat

In addition to a variety of biologically active phytochemicals present in plants (e.g. fruit and vegetables), it is good to know that there are several interesting bioactive compounds in meat and cured meat⁴⁸, such as **carnosine, choline, L-carnitine, acid conjugated linoleic acid, coenzyme Q10, glutathione, lipoid acid, bioactive peptides, taurine and creatine**, which have been studied for their physiological properties.

Conjugated linoleic acid (CLA): anti-carcinogenic properties

In meat there are also trans-fatty acids, which are formed as a result of bio-hydrogenation by bacteria in the rumen. The most common is conjugated linoleic acid (CLA), a trans-fatty acid that has been linked to several health benefits in the prevention of cardiovascular disease, diabetes and obesity. Almost 40 years ago, a substance that was capable of inhibiting the activity of mutagenic substances was discovered in roasted meat extracts. Subsequently, it was demonstrated that this substance was indeed **conjugated linoleic acid**, which in experimental studies has repeatedly demonstrated **strong anti-carcinogenic properties⁴⁹**.

Conjugated linoleic acid shows its anti-cancer activity already at relatively small concentrations, equal to less than 1% of food. It is interesting to note that among the other effects of CLA there is also the influencing of fat metabolism and that in experimental animals it reduces the amount of body fat.

The content of conjugated linoleic acid in milk and ruminant meat is influenced by diet, especially in the content of polyunsaturated fatty acids and by rumen conditions. **The intake of CLA food in our diet is completely dependent on the con-**

sumption of meat and milk of ruminants, in particular the consumption of milk and meat fats, with higher values in pasture animals, which generally also have higher levels of polyunsaturated fats.

Coenzyme Q₁₀: an antioxidant to fat levels

Coenzyme Q₁₀ is a component of the mitochondrial electron transport chain and to it is attributed antioxidant properties in fat, protein and DNA. Meat is an important source of coenzyme Q₁₀ and its content is closely related to the number of mitochondria present in muscle cells. The best sources are meat and fish, but cooking can cause a loss of about 15-32%.

Carnosine: anti-aging and antioxidant properties of cells

Carnosine is a dipeptide formed from the amino acids B-alanine and histidine. It possesses strong antioxidant and anti-genotoxic activities, as well as anti-aging properties of cells. In studies on mice fed with carnosine-supplemented diets, a lower oxidative and inflammatory progression induced by neurodegenerative diseases has been observed, from which it derives a possible role in the prevention of diseases such as Parkinson's disease. In muscle tissue it performs a buffer function and participates in various biological functions. It is located in meat and fish, but not in vegetables. Cooking meat reduces its content by 25-40%.

Taurine: a stimulant of the endocrine and immune system

It is a sulphured amino acid synthesised by methionine, found in the liver that can be both as a free acid and as a constituent of proteins, and is present in high quantities in most animal tissues. Taurine plays an essential role in the synthesis of bile acids that derive from cholesterol and

facilitate its elimination. Bile is also essential for the absorption of fat-soluble vitamins. Along with zinc, taurine is also important for vision. A critical role was revealed in 1975, when it was discovered that retinal degeneration occurred in subjects with a deficiency of taurine and it was found that consumption of formula-free milk without taurine could cause cardiac and retinal dysfunction in pre-term infants. Both of these problems can be prevented by adding synthetic taurine to artificial milk.

It is now recognised that taurine plays an important role in human physiology and nutrition, and that its positive effects are found in the digestive, endocrine, immune, muscular, neurological, reproductive, visual and cardiovascular systems. Studies in rats subjected to intense physical activity have shown that it reduces oxidative stress at muscle level and, therefore, the damage of muscle cells. Taurine seems to counteract the aging process thanks to its anti-free radical action. This amino acid is important for the synthesis of nitric oxide, a powerful vasodilator; as a result, it seems to stimulate efficiency and cardiac contractility, increasing myocardial blood supply. Taurine is only present in food of animal origin.

Creatine: for the improvement of muscle performance

Creatine and its derivative, creatine-phosphate, play an important role in muscle energy metabolism. So much so that, under certain circumstances, the addition of creatine to the diet promotes muscle performance. Muscle creatine is slowly converted into creatinine by the removal of water, with the formation of a ring structure, a phenomenon accelerated during the cooking of meat. Not being present in vegetables, those who follow a strictly

vegetarian diet have lower levels of creatine than non-vegetarians, and this can lower the level of muscle performance.

Glutathione: the most powerful antioxidant

It is a tripeptide formed by cysteine, glycine and glutamic acid. According to many authors it is the most powerful endogenous antioxidant: inside the cell, glutathione has the ability to inactivate free radicals such as hydrogen peroxide, thus protecting the cell from lipids or oxidised proteins and preventing DNA damage. Glutathione also exerts a detoxifying activity, blocking heavy metals such as lead, cadmium, mercury, aluminium and other toxic substances (drugs, alcohol, tobacco, etc.), so as to make it easier and faster to eliminate and preventing de facto that these poisons bind to the SH groups of tissue proteins and enzymes deteriorating them. Furthermore, it favours the bioavailability of iron. Finally, glutathione carries out a pro-immune activity and protects the central nervous system. Some fresh vegetables, eggs and meat, especially pork and beef, have high glutathione contents.

Lipoic acid: antioxidant molecule

Lipoic acid is an antioxidant molecule capable of protecting both the membranes and the organelles of the cell; it is present in the mitochondria of animal cells, then in larger quantities in the muscles of the animals that move the most. **Lipoic acid is also a powerful chelator**, capable of removing excess metals, such as iron and copper, and toxic metals such as cadmium, lead and mercury.

L-carnitine

L-carnitine is a small molecule derived from lysine that plays an important role

in the metabolism of fatty acids, facilitating their entry into the mitochondria and their consequent oxidation. L-carnitine is produced from methionine and lysine and its synthesis is strongly influenced by the bioavailability of these elements. After its biosynthesis, the L-carnitine passes into the blood and is distributed to organs and tissues, depending on their energy capacity, especially to the muscles and the heart. In addition to its endogenous origin, L-carnitine is supplied by foods. With an omnivorous diet, at least 80% of the L-carnitine present in the body derives from the diet.

The percentage decreases dramatically in vegan diets because most of the L-carnitine is supplied by meat, fish and dairy products. It is considered to be a vitamin-like nutrient and the lack or insufficient supply of L-carnitine in muscles or in cardiac cells can cause myopathies and cardiac disorders.

Choline: the memory of a lifetime

Choline is an essential nutrient that is found in many food sources and plays a critical role in the development of the central nervous system. Pregnancy and breastfeeding are periods in which the choline maternal reserves tend to run out. Animal studies have shown that the pre- and post-natal choline status can have long-lasting effects on the attention and memory of the unborn child. Choline during pregnancy and during the early stages of life can change brain functioning, resulting in improved memory throughout life. This change in memory function seems to be the cause of changes in the development of the memory centre (hippocampus) in the brain, with long-term effects so much so that memory in the elderly may, in part, be determined by what the mother ate during pregnancy.

cy. The richest choline foods are beef liver, chicken liver and eggs, but also pork meat.

Choline as a precursor of acetylcholine is involved in the regulation of sleep, in the control of muscle activity, in the regulation of anxiety states, in learning and may be linked to a slowing of the loss of cognitive abilities in the elderly.

Bioactive peptides of meat: immune system strengthening with a protective activity

In addition to bioactive compounds, in meat there are peptide derivatives of proteins that are another group of compounds functional with protective activity. When evaluating the quality of a protein, in addition to the composition of essential amino acids, it is also important to consider their ability to generate specific bioactive peptides during digestion. Bioactive peptides are sequences of 2-3 amino acids with protective effect on consumer health and play an important role especially in the prevention of diseases associated with the development of the metabolic syndrome and mental illnesses. Meat contains different proteins and peptides with important physiological activities. Although the activity of these peptides is latent, when they are part of the protein sequence, during digestion in the gastrointestinal tract they are released and activated. The same happens during fermentation, seasoning or food processing. Peptides modulate physiological functions through the binding interactions to specific receptors on cells that lead to physiological responses.

For example, it has been demonstrated that collagen-derived peptides have a positive effect on bone function, but in general the beneficial health effects of meat peptides include **antihypertensive**,

antioxidant, **antithrombotic**, **modulating immune response** and **antimicrobial effects**.

2.2 Are there any alternatives to meat consumption?

In all parts of the world, the Guidelines for Healthy Eating recommend a high consumption of fruit, vegetables, cereals, legumes, foods rich in essential nutrients and protective substances, essential for the health of the organism⁵⁰.

An exclusively vegetable nutrition must be integrated with a careful selection of foods and supplements⁵¹. Some nutrients like mineral salts, vitamins like A, D or B12, essential fatty acids (especially omega-3) or essential amino acids (for example, methionine and threonine in addition to tryptophan and lysine) may not be consumed in optimal quantities, especially in more restrictive vegetarian diets⁵².

An example can also be that of iron which is present in many plant foods. By consulting the composition tables of foods, it turns out that spinach is the vegetable that contains more (2.9 mg/100g), and in legumes, lentils and beans are the richest (8-9 mg/100 grams of dried legumes).

Unfortunately, for metabolic reasons, our body is able to absorb at best 8% of these quantities: this means that to cover the daily need for iron using only raw spinach you would have to eat between 4 and 17 kg per day because boiling causes it to lose a lot in the cooking water.

This example shows how it is essential to take into account **bioavailability, that is the aptitude of a nutrient to be absorbed by the intestine** and then the assimilation by the cells that must use it. Many factors can influence the bioavailability of iron. **Vitamin C increases it**, so it is good prac-

tice to season vegetables cooked with lemon or eat fruits and vegetables that contain vitamin C; the fibre makes it decrease, as well as tannins.

Many scientific studies have focused on the role of quantity, quality, type and timing of protein consumption and consequences of effects on health⁵³.

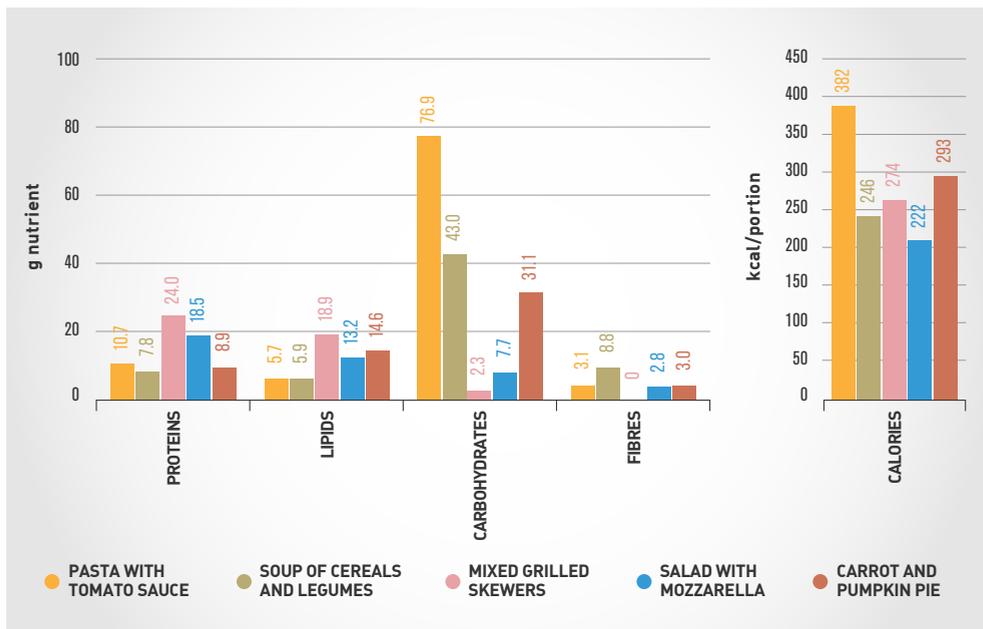
Today it is believed that a daily protein intake moderately superior to the recommendations (recommended intake for the population - 0.9 g/kg × day) for adults⁵⁴ may be useful for some people, such as the **elderly**⁵⁵ and physically active individuals⁵⁶.

Furthermore, a moderately high **protein intake in the diet** can help reduce **the risk of chronic diseases such as obesity, cardiovascular disease, type 2 diabetes,**

osteoporosis and sarcopenia⁵⁷. But it is essential that it derives from different types of foods, both of animal and vegetable origin.

In the group of foods rich in proteins, those of animal origin, in addition to providing complete proteins from the amino acid composition point of view, contribute to the daily intake of nutrients such as iron, zinc, vitamin B12, phosphorus and calcium, while proteins of plant origin contribute more to the intake of dietary fibre, vitamin E, magnesium. It is precisely these characteristics that support the advice for eating a variety of protein food sources, both for health reasons and to help meet nutritional recommendations⁵⁸⁻⁵⁹.





The value of a varied and balanced diet is evident in the analysis of the contribution of nutrients from different foods

RECIPE	INGREDIENTS (PER PORTION)
 PASTA WITH TOMATO SAUCE	Pasta 90g, Peeled tomatoes 80g, Oil 5g
 CEREALS AND LEGUMES SOUP	Cereals 50g, Legumes 40g, Oil 5g
 MIXED GRILLED SKEWERS	Chicken breast 40g, Pork sausage 40g, Veal rump 40g, Peppers 30g, Oil 7g, Wine 10g
 SALAD WITH MOZZARELLA	Cabbage 50g, Tomatoes 50g, Mozzarella 80g, Green salad 50g
 CARROT AND PUMPKIN PIE	Eggs 20g, Almond flour 25g, Sugar 25g, Carrots 15g, Pumpkin 10g, Powdered sugar 2g

By comparing the nutritive elements of some recipes, we can see how, in a balanced diet, meat provides more proteins than other foods.
 [Source of the recipes: Elaborations within the working group]

3 THE NEEDS DURING THE DIFFERENT PHASES OF AN INDIVIDUAL'S LIFE

The nutrient requirement starts at the beginning of life and continues in all its phases, with variations due to age and specific needs. All nutrients are essential, but each period of life is characterised by a lesser or greater requirement of some nutrients or energy. **Meat provides useful nutrients at all stages in life**, but there are some special situations such as pregnancy and lactation, as well as during growth and exercise, where it is advisable not to deprive yourself of this food. For example, during pregnancy, breastfeeding, growth and aging the needs of certain nutrients or compounds increases such as proteins, essential fatty acids, choline, and micronutrients such as iron, zinc, calcium and vitamin B12, and you should not forfeit the best sources of these nutrients: foods of animal origin. Adults can satisfy their needs even with limited quantities of meat.

Recently a position paper⁶⁰ of the Sippo (Italian Society of Preventive and Social Paediatrics), together with the FIMP (Federation of Italian Medical Paediatricians) and the Italian Society of Perinatal Medicine has decided to clarify the adequacy of vegetarian diets and concludes that vegetarian and vegan diets that are not supplemented (with vitamin B12, DHA, iron, vitamin D, calcium and zinc) must be considered inadequate to guarantee a correct psychomotor development. Pregnant or nursing women, children and adolescent vegetarians must be periodically

evaluated to verify that the supplementation is sufficient.

3.1 Pregnancy and lactation

The baby in the womb is totally dependent on the nutrients that are provided by the mother. Maternal eating habits and the nutritional status before conception, during pregnancy and lactation affect the unborn child, its growth and its health. Therefore it is important that the foods that a pregnant or nursing woman takes provide all the necessary nutrients to support the growth and development of the child, and this can only be achieved through a varied and balanced diet.

Proteins are a primary nutrient, because they guarantee the bricks necessary for the construction of the tissues of the unborn child: it goes from two cells at the time of fertilisation to about ten thousand billion in the new-born! But we must provide also the proteins necessary for the development of the placenta, for the mother's mammary and uterine tissues and for the growth in volume of the circulating blood (more haemoglobin, more proteins of the plasma), besides that of the amniotic fluid. Foods that contain proteins of high biological value are milk and derivatives, eggs, meat and fish. The same foods help to supply the body with other important nutrients during pregnancy and lactation like calcium, iron,

zinc, iodine, B vitamins, vitamin D, and some fats from the omega-6 family, such as arachidonic acid (AA).

In pregnancy and during lactation a frequent consumption of **fish is highly recommended to obtain the precious long-chain omega-3 fatty acids**, present albeit in smaller quantities even in meat, such as **docosahexaenoic acid (DHA)**. In fact, DHA is one of the main structural components of cell membranes and is essential for the formation of new tissues, **in particular for foetal development of the brain, nervous system and retina, which continue to mature during the first months of life.**

A good supply of calcium, together with phosphorus and vitamin D, is essential for foetal development and the first months of life. It is not only bones and teeth that benefit from it, but also the nervous functions, muscular contractions and blood coagulation. In pregnancy it is also necessary to pay close attention to the intake of sufficient quantities of iron and iodine. The greater iron requirement is due to the greater volume of blood: the baby's cells breathe with oxygen transported by the iron (haemoglobin) of the mother. Adequate iodine intake is essential for an optimal production of thyroxine, a thyroid hormone needed in larger quantities to control the major underlying metabolism induced by pregnancy. In addition to consuming fish regularly, it is good to replace salt with iodized salt.

During pregnancy, iron deficiency can impair brain functioning, learning and memory: children with low levels of iron have a delay of neuro-cognitive and motor development, a fact confirmed also by a recent research conducted at the paediatric hospital in Los Angeles and

published in Paediatric Research⁶¹, one of the most prestigious magazines of the sector.

All vitamins are important in pregnancy, but some even more so: **vitamin A and vitamin C, necessary for tissue growth, and B vitamins**, essential for energy transformation and protein metabolism, found in cereals, legumes and foods of animal origin. Special attention is needed for folic acid, an essential vitamin for the proper development of the foetus's spinal cord in the first 3 months after conception, to the point that during pregnancy a higher consumption is recommended. It also intervenes in the formation of red blood cells and is capable of reducing the risk of heart disease. During this phase of life, the **requirement of vitamin B12** also increases, **which goes from 2.4 µg per day to 2.6 µg in pregnancy and 2.8 µg during lactation.**

3.2 Growth and development

The nutrition of children and adolescents is based on the same principles of adult nutrition, but with different quantitative needs. The first 2 to 3 years of a child's life are fundamental for his physical and mental development, and in this context, proteins play a key role in the correct functioning of bones, muscles, blood, skin and hormones. Animal proteins, especially meat, are therefore very important foods: an 80 to 100 gram portion of most types of meat contains about 20 grams of protein, an easy way to help the child achieve its goals of protein intake. In addition to this, a correct intake of vitamin B12 is essential to all the other stages of life and if it does not feed properly it can get sick easier, or in general not develop in the right way. For

example, it is at this stage that obesity can be promoted in adulthood. In fact, today it is understood that fat cells are formed during childhood: if a child eats too much, it produces a greater number of fat cells that remain virtually unchanged in quantity when an adult⁶². Therefore, it will have a greater risk of becoming obese. Some nutritional deficiencies, **such as iron deficiency, can cause low levels of attention and concentration in the child, with consequent poor academic results**⁶³.

Most of the studies investigating the association between nutrition and cognitive development have focused on single micronutrients that are considered essential for the proper development of the brain: they are omega-3 fatty acids, vitamin B12, folic acid, zinc, iron and iodine⁶⁴, all nutrients supplied preferentially from food of animal origin. In children, the association between **vitamin B12 and cognitive development** was observed above all in children born to vegetarian or vegan mothers or who followed a macrobiotic diet. These diets can cause vitamin B12 deficiency because vitamin B12 is found exclusively in foods of animal origin. Studies on children with vitamin B12 deficiencies have highlighted abnormal clinical and radiological signs, including: hypotonic muscles, involuntary muscle movements, apathy, and reduced growth and demyelination of nerve cells. After treatment with vitamin B12, a rapid improvement occurs of the neurological symptoms in children with deficiencies, but in many the damage is permanent with lifelong delays in cognitive development and language⁶⁵. The long-lasting effect of vitamin B12 deficiency is supported by the results of some studies⁶⁶ in which researchers examined the cognitive functioning of adolescents who con-

sumed a macrobiotic diet up to the age of 6, compared to boys who followed an omnivorous diet. Those adolescents who followed a macrobiotic diet up to 6 years of age had lower levels of fluid intelligence, spatial capacity and short-term memory compared to control subjects.

Zinc deficiency appears to be a major problem worldwide, affecting 40% of the population. Some research suggests that children, adolescents, elderly and people with diabetes are at high risk of zinc deficiency⁶⁷. Zinc is thought to be an essential nutrient for the brain, with important structural and functional roles. More specifically, zinc is a cofactor for more than



200 enzymes that regulate different metabolic activities of the body including proteins, DNA and RNA synthesis. Furthermore, zinc plays a role in neurogenesis, maturation and migration of neurons and synapse formation.

Zinc is also found in high concentrations in the synaptic vesicles of the hippocampal neurons (which are involved in the learning and memory centre). Zinc supplementation has a positive effect on the immune status of new-borns and can prevent congenital malformations⁶⁸.

One of the most common nutritional deficiencies in both developing and developed countries is **iron deficiency**. It is believed that iron is involved in different enzyme systems in the brain, including those involved in energy production, in the synthesis of dopamine receptors, in the myelination of nerve cells and in the regulation of brain growth. Furthermore, iron appears to modify developmental processes in hippocampal neurons by altering dendritic growth. Some authors have found significantly lower performances in language skills, motor skills and attention in 5-year-olds, whose levels of ferritin were lower⁶⁹. There is a broad scientific consensus⁷⁰ that iron deficiency has a negative impact on cognitive, behavioural and motor skills and these cognitive deficits can appear at any age. The lack of iron is in fact clearly linked to cerebral alterations at the hippocampus level, mitochondria of the brain, metabolism of dopamine, a neurotransmitter, and the myelination of nerve fibres.

One of the most worrying consequences of **iron deficiency in children is behavioural alteration and cognitive performance**, for which there is a wealth of clinical, biochemical and neuropathological research that shows how iron deficiency

can have a deleterious direct effect on brain learning and development, which can also occur with normal haemoglobin levels⁷¹.

Iron supplementation improves cognitive functions and meat, especially beef, provides heme iron, a different form of iron that the body absorbs to a greater extent and is not found in plant or fortified foods. If iron deficiency occurs very early in life, the damage can be irreversible, and it may not be possible to reverse the brain damage with iron treatment⁷².

Infants who are breast-fed only, at 9 months of age, get only 10 percent of the iron and zinc they need, and if during post weaning there are only cereals, fruit and vegetables they only get 30% of their needs of these important nutrients. Introducing meat instead as early as the sixth month is an effective way to provide iron and zinc in appropriate quantities⁷³.

Meat and other products of animal origin, such as milk, contain nutrients such as iron, zinc and calcium which is difficult to find elsewhere, or which are in a highly absorbable form and usable by the body, such as iron.

The World Health Organization recommends the intake of food of animal origin from 6 months of age, highlighting how diets based only on vegetables are not able to meet the nutritional needs of the child, unless the use of supplements or fortified products is used⁷⁴.

3.3 The nutrition of adults

During this phase of life, it is important not to increase weight too much, because overweight and obesity are connected to greater health risks. Meat, given its high nutritional density, can therefore be of help to limit calories, while ensuring an

adequate supply of nutrients. The prevalence of obesity in Italy has more than doubled in the last 25 years and numerous studies indicate that diets with higher proportions of proteins, obtainable for example with lean cuts of meat and cured meats, are effective for weight loss and maintenance. Meat, thanks to its protein contribution, can also contribute to satiety and consequently reduce the intake of food and energy. As with children and adolescents, adults are also at risk of iron, zinc and iodine deficiencies. Only an adequate diet, which includes also foods of animal origin and in particular meat, can avoid this risk.

A study⁷⁵ conducted on 127 young non-anaemic women between 18 and 35 years which wanted to evaluate the relationship between iron status and cognitive performance, highlighted the association between some haematological indicators of the iron status (haemoglobin, amplitude of blood cell distribution, saturation of the transferrin, ferritin, transferrin receptor, and total body iron) with brain function (attention, logic, memory, etc.). In practice better the iron status, better is the performance in sustained attention tasks and planning ability.

3.4 Meat for sportsmen

It is important for those who practice physical activity to follow a healthy and balanced diet, which provides calories and nutrients sufficient to meet the energy and nutritional needs and can ensure optimal performances during exercise⁷⁶. A good nutrition in fact helps the athlete to train hard, to recover quickly and to adapt effectively to environmental conditions, with less risk of illness and injury. It is no coincidence that physical activity creates

a higher energy demand, as well as macronutrients such as carbohydrates, fats and proteins.

Carbohydrates and fats are the primary fuels for exercise, while proteins are necessary for the growth and repair of body tissues: the muscles contain about 40% of the total proteins of the body. When the requirement of amino acids is not satisfied by the diet, **the muscle proteins supply the body with the necessary amino acids, but this happens even after exercise, during the phase of recovery, during which it is essential that there is an adequate supply of protein.**

Numerous studies have shown that the consumption of proteins, and in particular of the essential amino acids that constitute them, before, during, but especially immediately after the workout is capable of stimulating muscle protein synthesis. It is clear that proteins alone are not enough. But studies on the effects of protein on muscle power have identified some forms, that more than others, are able to optimise muscle protein synthesis, inhibit protein catabolism and therefore stimulate muscle growth. In fact, it is necessary to favour proteins rich in essential amino acids, such as those supplied by milk and its derivatives, eggs, fish and meat. Foods or snacks that contain high quality protein, such as meat and cured meats, fish, eggs or milk should be consumed regularly during the day. In particular, immediately after exercise, to **maximise protein synthesis, to help maintain muscles and help repair damaged tissues.**

Exercise increases the need for some vitamins and minerals. A varied diet capable of balancing energy expenditure satisfies the greater needs of athletes

for some micronutrients, but for others, present in a highly digestible form in the products of animal origin like calcium, iron, zinc and magnesium and vitamin B12, there may be a deficiency problem especially in athletes and vegetarians. Iron is a vital component of haemoglobin and myoglobin, proteins found respectively in red blood cells and muscles. **Haemoglobin and myoglobin provide oxygen to the tissues during exercise and the athletic performance of athletes**, especially aerobic sports athletes, depends strongly on the oxygen supply to the muscles so that they can work efficiently. When the state of iron becomes low, less oxygen is delivered to the muscles and sports performances are reduced. Iron deficiencies, often evident in athletes, can therefore compromise sports performances and can be avoided by the intake of highly absorbable and usable iron, such as that contained in beef.

Zinc intervenes in many very important functions such as growth, construction and repair of muscle tissue, the transformation of energy. Athletes, especially women, are at risk of deficiency of this mineral, whose best food source is represented by meat, but also by eggs and fish products.

Some B vitamins (thiamine, riboflavin, vitamin B6, niacin, pantothenic acid, biotin) are involved in the energy transformation process during exercise, while folate and vitamin B12 are necessary for the production of red blood cells, protein synthesis, tissue repair and maintenance. Although the need for these vitamins is slightly higher in athletes, it is generally covered by the increased energy intake necessary for athletes to maintain body weight.

3.5 The importance of foods of animal origin for the elderly

After 70 years of age you need less calories, because you no longer move like before and metabolism slows down. But to maintain health **the organism still requires the same amount of nutrients and even higher levels for some of them, like proteins.** Even the stomach and the intestine become less efficient. There is a decrease in gastric acid secretion, which can limit the absorption of iron and vitamin B12. With passing of years, the body reduces progressively the perception of feeling hunger and thirst; the regulation mechanisms of glucose and protein synthesis also become less efficient. Even taste fades and very tasty foods tends to be preferred, or excessive quantities of salt and seasonings are added to the food. The losing of teeth or the decrease in taste and smell always make favourite foods less attractive⁷⁷.

Meat and cured meats are part of a balanced diet for the elderly⁷⁸ and their consumption is recommended as it provides high biological value proteins and microelements including iron, vitamin B12, zinc and selenium. Once you reach adulthood muscle mass begins to decrease and the rate at which it is reduced accelerates after 50 years of age: **muscles represent about the 45% of body weight between 20 and 30 years, falling to only 27% of body weight at the age of 70.**

This tendency to lose muscle mass, called **sarcopenia**, is accentuated if one does not assume sufficient quantities of protein. It is therefore very important for adults to consume adequate amounts of high quality protein at every meal, in combination

with exercise⁷⁹. It is clear that essential amino acids are fundamental for **the optimal stimulation of the synthesis of muscle proteins** and the amino acid leucine is a powerful signal of this process. Animal proteins have the highest proportion of the amino acid leucine⁸⁰.

Sarcopenia has numerous consequences in the elderly: **loss of strength** and ability to perform the activities of daily life, **loss of independence, an increased risk of falls⁸¹, frailty, disability, poor health and lower longevity⁸²**. In the PURE study, for example, which followed 140,000 adults aged between 35 and 70 in 17 countries, it was shown that greater muscle strength is associated with longevity and reduced cardiovascular risk⁸³.

A slightly larger amount of protein than in adulthood can be useful for the elderly, who can increase their reserve capacity and counteract the progressive loss of muscle mass, but also **to prevent the fragility of the skin and the reduction of immune functions, resulting in better recovery from disease⁸⁴**.

A vitamin B12 deficiency in the elderly is associated with decreased memory and hearing. Another nutrient at risk of deficiency in the elderly is **zinc, involved in the process of healing wounds, vision, taste and smell**. Most of the nutrients for which the needs in the elderly are increasing are found in large quantities and in easily assimilated form in foods of animal origin.



4

FOOD AND HEALTH

Dietary habits are intimately linked to different aspects of human life, such as growth, development, resistance to disease, and it is well established that they represent the most influential environmental factors in duration and quality of life.

To date, many nutritional strategies have been studied to prevent or delay the beginning of a disease, or even to optimise the therapy. But it is clear that not all individuals respond in the same way to dietary changes and part of this variability is due to individual genetic and epigenetic differences, which can in turn influence absorption, digestion, metabolism, excretion and the action of bioactive food compounds. Although dietary factors are important in many of the chronic degenerative diseases that are the main causes of illness and death in wealthy societies, it is very difficult to determine with certainty a cause-effect relationship. In fact, chronic diseases have many causes and take years to develop: eating habits can however be clearly a “risk factor”.

The scientific methods for investigating chronic diseases, their causes, treatment and prevention are mostly epidemiological, a method that studies the prevalence of the frequency with which diseases occur and the conditions that favour or hinder their development, including dietary habits. These studies can focus on the subjects after the diagnosis of the disease (retrospective studies), or before

the diagnosis (prospective studies). The influence of data and recommendations from developed countries on nutritional guidance **has often overshadowed the recognition of essential micronutrients and the contribution of proteins which, for example, meat contributes towards and whose legacy of key proteins and micronutrients is often underestimated⁸⁵**.

For example, in recent decades there has been an increase in the prevalence of some chronic diseases related to diet and lifestyles such as overweightness and obesity, hypertension and diabetes. While the incidence of these diseases continues to grow over the years, the general increase in food consumption that characterises the era in which we live, has partly reversed the trend, especially for some foods such as meat, whose daily intake has decreased over time.

The key to the meat question is therefore the quantity that should be consumed because, being a food with a high nutritional efficiency, in the modest quantities foreseen by the Mediterranean food model it already permits the benefiting from its precious effects without causing health risks⁸⁶. Because if it is true that too little meat can slow down development and knowledge, excessive consumption seems to be associated with other health problems, such as vascular and neoplastic ones. Although there is a probable relationship between a excessive consumption of red meat and cancer or cardiovascular disease, the results of

the research are not entirely consistent and they differ amongst the populations, making it difficult to understand the reasons for this correlation⁸⁷.

According to scientific studies, in fact, the relationship between meat and mortality risk is more pronounced in the United States, compared to what happens in Europe or in Asia. This could be due to several factors:

- **Americans consume meat in much higher quantities than the average European and twice as much as in Italy;**
- **Europeans do not grill meat with the same frequency as Americans;**
- **The type of meat consumed by Americans comes predominantly from castrated animals, which results in a much higher fat content than the European average; furthermore, these fats are not superficial but are present in the lean part of the muscle and therefore difficult to remove;**
- **American farms allow the use of natural hormones for growth.**

The main diseases closely associated with nutrition are cardiovascular diseases, obesity, diabetes and some forms of cancer.

4.1 Cardiovascular diseases: saturated meat fats are acquitted after 40 years of accusations

Diseases that affect heart and blood vessels - cardiovascular diseases - include numerous health problems, many of which are linked to a process called arteriosclerosis, a condition that develops when a substance called plaque is deposited on the walls of the arteries. Its accumulation restricts the arteries, making

the flow of blood more difficult. If a clot forms inside the arteries, blood flow can be stopped. This can cause a heart attack or stroke. **Cardio-cerebrovascular diseases are one of the most important public health problems in Italy. In 2014 there were a total of 220,200 deaths in Italy due to circulatory system diseases (96,071 in men and 124,129 in women); of these, 69,653 deaths were attributed to ischemic heart disease (35,714 in men and 33,939 in women) and 57,230 to cerebrovascular diseases (22,609 in men and 34,621 in women).**

Cardiovascular diseases are for the most part preventable through the adoption of healthy lifestyles, especially **healthy nutrition, regular physical activity and the abolition of cigarette smoking.** Meat is often considered with concern regarding **heart health, but not all scientific studies agree on this point.** A systematic review of the literature of 11 epidemiological studies published in 2015 found that a high intake of red meat is a significant risk factor for coronary artery disease (CAD) in 4 studies, but no significant association was found in 5 other studies⁸⁸.

A reasonable amount of lean beef can be included in a healthy heart diet, and can have favourable effects on the metabolic syndrome and coronary heart disease.

For example, in some studies it has been observed that adults with high cholesterol, taking 100-115 g of lean beef per day, but limiting the intake of saturated fat to less than 7% of total calories, have had a significant decrease in total cholesterol and LDL cholesterol compared to subjects with a diet low in meat but with 12% of total calories from saturated fats⁸⁹. Another meta-analysis study published in 2010⁹⁰ showed a significant increase in the risk of coronary heart disease with

the increase in consumption of processed meat: a contribution of 50 g of processed meat per day (which is more than twice that consumed in Italy) was associated with an average risk increase of 42%, while no correlation was shown with an intake of red meat (risk relative [RR] = 1.00). The EPIC study also showed a significant increase in the risk of death due to cardiovascular disease linked to the increase in consumption of processed meat (HR 1.72 [95% CI 1.29-2.30]) comparing higher and lower consumption (> 160 g per person per day compared to 10-19.9 g)⁹¹. There was no significant correlation with unprocessed white and red meat with regards cardiovascular death.

In summary, the indications of the WHO to prevent cardiovascular diseases are to reduce the consumption of saturated fats, in order to control the level of “bad cholesterol” in the blood: hence the suggestion to prefer lean cuts in the choice of meats. But also to pay attention to other foods: **saturated fats are also present in dairy products, in many baked goods and fried foods.** Some plant foods, such as **palm oil or coconut oil**, for example, contain **large quantities of saturated fats.** Taking into consideration the food composition tables of some products already shown in the nutrients section, it turns out that meat and cured meats are in effect among the least responsible foods for the intake of saturated fats.

In 2017, the results of the important PURE study do not support current recommendations to limit daily intake of fats to less than 30% of total energy and that of saturated fats to less than 10%, because **it is unlikely that decreasing the overall consumption of fat leads to an improvement in health, as would happen by reducing carbohydrate consumption.** Limiting to-

tal fat consumption to around 35% of energy taken daily and contemporaneously carbohydrate intake can reduce the risk of total mortality.

4.2 Tumour pathologies

Cancer is one of the main causes of morbidity and death all over the world: on average each year there are about 14 million new cases and 8.2 million cancer-related deaths. More importantly, it is expected that the number of new cancer cases will grow by almost 70% over the next two decades, up to 22 million new cases per year, making tumours the likely number one cause of mortality all over the world⁹². The five most common types of malignant cancer in men are those of the lung, prostate, colorectal, stomach, and liver tumours; on the other hand, the five most common types of neoplasms in women are breast cancer, colorectal, lung, cervical and stomach cancers.

Although dark areas remain, it is now established that the **interaction between genetics and the environment promotes carcinogenesis.** In particular, some physical carcinogens (such as **ultraviolet and ionising radiation**) and biological (**viral, bacterial or parasitic infections**) interact with behavioural and **food risk factors such as obesity**, insufficient consumption of fruit and vegetables, **lack of physical activity, the use of tobacco and alcohol**, to promote the transformation of a normal cell into a malignant cell. A phenomenon that can be amplified in individuals particularly predisposed genetically⁹³. Amongst the various factors, **eating habits play an important role in increasing or reducing the risk of various cancers.** Although the causal relationship between

diet and cancer is complex and can hardly be unveiled due to the fact that diets are characterised by many different foods and nutrients, there is substantial evidence that certain foods may be more harmful than others⁹⁴. Despite progress in scientific knowledge, however, areas of disinformation persist, sustained by prejudices and health simplifications, not always spread correctly by some mass media. And so foods are often classified as “**good**” and “**bad**”, which disorients the consumer even more.

In fact, **no product can be considered good or bad for health, but must be evaluated by the nutrients which its contributes towards the daily diet, keeping in mind that the daily limit for each category of food in a balanced diet is not exceeded.** It must in fact always be remembered that cancer diseases are diseases extremely complex because:

- there are over 100 types of cancer for which the causes are not always known;
- people’s diets contain an almost imponderable number of different components, some of them may decrease and others increase the risk of developing tumours;
- the development of a tumour takes place over a very long time making it very difficult to establish a sure and reliable relationship of cause and effect;
- many questions on diet and tumours remain unanswered, and often studies are based on tests done on animals in the laboratory without direct evidence on humans;
- recommendations for a correct diet that reduces the risk of contracting a tumour must be based on relevant scientific evidence, and not refer to a single study.

Meat is certainly one of the most controversial foods because excessive consumption, especially red and processed meat, can contribute to the risk of cancer⁹⁵.

The press release of the International Agency for Research on Cancer (IARC) issued on October 26th, 2015 and the IARC report Red Meat and Processed Meat volume 114 published in 2018⁹⁶ reported a high level of attention on the topic, as consumption of red meat and processed meat has been classified respectively as “probably carcinogenic to humans” and “carcinogenic to humans”⁹⁷⁻⁹⁸.

IARC studies

As seen, the nutrition-cancer correlation is very difficult to study because there are many elements, real or presumed, that can favour the onset and development of tumour pathologies. In support of the recommendations of national authorities there are the studies of the International Agency for Research on Cancer (IARC) based on national studies that highlight and classify the **agents considered, undoubtedly or presumably, responsible for the onset of tumour pathologies.**

The mere presence of an agent in the classification does not immediately make it dangerous because it is necessary to understand, in addition to the level of carcinogenicity, also what are the **quantities and durations of exposure** that transform the theoretical into real risk, as well as what the real factors of risk are. Cigarette smoke is certainly carcinogenic, but those who smoke a single cigarette a day do not run a real risk of tumour development. The chemical compounds that are generated in cooking over a high flame and involve the burning of food are risky: **the**

modification of cooking habits immediately reduces the risk. In the case of processed and red meats, the most probable cancer pathology is related to colorectal which could be more likely attained by consumers of large quantities than moderate ones. The IARC studies have associated **excess consumption with an increase in the relative risk** of about 18% for transformed and 17% for red meat. It is essential, however, not to confuse **absolute risk** (for simplicity we could say real) with relative, which **only represents the increase of the absolute risk.** IARC data tell us: people that consume larger quantities of red meat (more than 100 g per day) have a 17% increase in the risk of colon cancer compared to those who con-

sume a small amount of meat. According to IARC, processed meat increases the risk by 18% with 50 g per day. These figures, however, represent a relative risk. In reality they mean that if 6% of people in a population are likely to develop colon cancer (60 out of 1000 people), among those who eat small amounts of meat this number is more likely to be 5.6% [56 people in 1000], and among high-volume consumers this number is expected to rise to 6.6% [66 people in 1000].

So the absolute risk between those who eat too much or too little meat is only 1%. Another very important element concerns the quantities covered by IARC research, which are 50 g of processed meat or 100 g

IARC CLASSIFICATION

Amongst all classified agents, only 6 (red meats, processed meats, coffee, alcohol, maté, salted fish Chinese style) are foods/beverages.

The others are made up of substances or molecules belonging to various groups, amongst which pollutants and by-products of industrial production stand out. All other agents are chemicals or work environments that are potentially at risk.

GROUP 1 CARCINOGENIC TO HUMANS an agent characterised by an evident level of carcinogenicity in humans. This class contains 120 substances (e.g. tobacco smoke, alcohol (from 2012), arsenic, asbestos, plutonium, atmospheric pollution, solar radiation, etc.).

GROUP 2A PROBABLY CARCINOGENIC TO HUMAN limited evidence of carcinogenicity in humans and sufficient evidence in experimental animals. The substances included in this category are 82, the only food/drink present is maté (infusion) incriminated also by the fact of being consumed very hot, a risk factor for cancer of the oesophagus and the oral cavity.

GROUP 2B POSSIBLY CARCINOGENIC TO HUMANS limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. A category that includes 302 substances.

GROUP 3 NOT CLASSIFIABLE AS TO ITS CARCINOGENICITY TO HUMANS a category usually used for agents for whom the evidence of carcinogenicity is inadequate in humans and inadequate or limited in experimental animals. This is the most numerous category with 501 substances.

GROUP 4 PROBABLY NON CARCINOGENIC TO HUMANS absence of carcinogenicity both in humans and in experimental animals. At the moment the only substance included in this category is caprolactam, the precursor in nylon production.

of red meat per day. These consumptions are **much higher than those of typical Italian consumers** and, in general, those of the world. The **Global Burden of Diseases Risk Factors Study 2017 (GBD 2017)** provides a comprehensive assessment of risk factor exposure and attributable burden of disease (www.healthdata.org/gbd). It is proposed as a targeted health measurement system to estimate the weight of individual factors (for example Behavioral risks such as smoking or alcohol use) on the development of diseases to monitor risk exposure trends critical to health surveillance and inform policy debates on the importance of addressing risks in context. Considering data in Western Europe (Causes, All ages, Percent of total

deaths), it emerges that colorectal cancer is actually one of the main causes of death in developed countries (at seventh place in 2017), but with a rather low incidence (about 3.48% of deaths in 2017). If the analysis moves onto the behavioral risks, regardless of the type of disease generated, it is interesting to observe that in Western Europe the first risk factor is smoking, followed by alcohol use.

Considering dietary factors, diet low in whole grains is a huge risk factor when compared to a diet rich in red meat (41.6 versus 1.14): a further confirmation of the importance of following the indications proposed by the Mediterranean Diet.

BEHAVIORAL RISK FACTORS FOR HEALTH: NUMBER OF DEATHS EVERY 100,000 PEOPLE



Source: GBD 2017 Institute for Health Metrics and Evaluation; extraction made in March 2019 taking into account behavioural risk factors in Western Europe

CANCER RISK

ABSOLUTE AND RELATIVE

Absolute risk

is the likelihood of a health effect occurring under specific conditions

for instance, the chance of a person developing heart disease is **based on factors** such as:

-  age
-  physical activity
-  sex
-  genetics
-  diet

commonly expressed as:



a 1 in 10 chance of developing heart disease

a 10% chance of developing heart disease



Relative risk

is the likelihood of an event occurring in a group of people compared to another group with different behaviours, physical conditions or environments

VS

- meat eater  vegetarian
- inactive  physically active people
- overweight  normal body weight
- low income  high income

for instance expressed as: processed meat consumption **increases risk of bowel cancer by 18%**

Relative risks alone do not tell the full story...

If **absolute** risk is 2 in 10...



50% increase

...risk increases to 3 in 10



If **absolute** risk is 4 in 10...

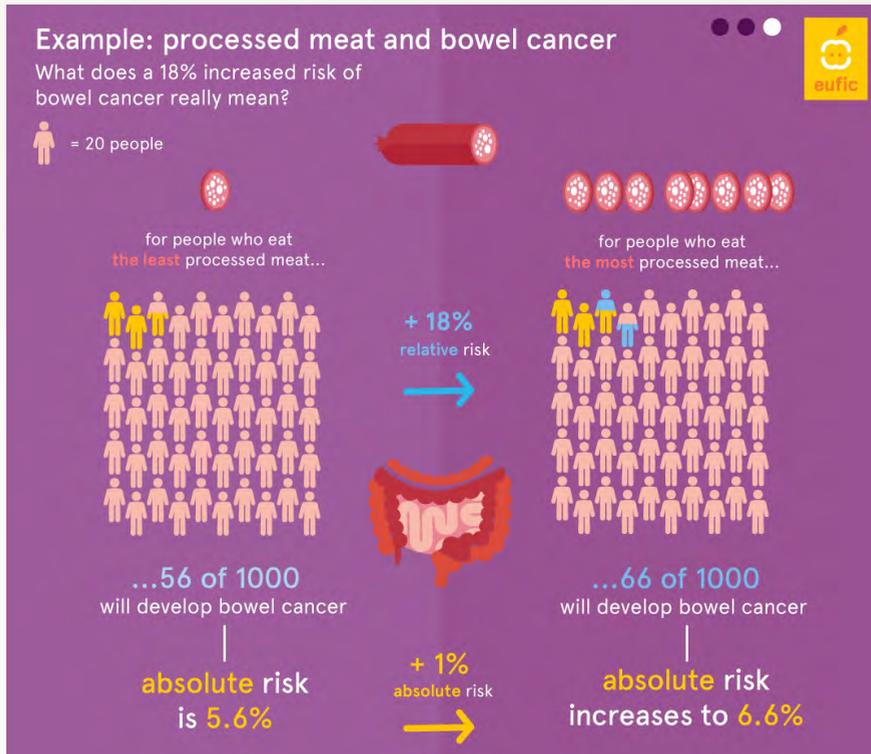


50% increase

...risk increases to 6 in 10



Absolute risk numbers are needed to understand relative risks!



Source: EUFIC, 2015 - How to talk about food risk? A handbook for Professionals. pp. 40-41

In the report “How to talk about food risk? A Handbook for Professionals”, the EUFIC, the European information food board council (a non-profit organisation, established in 1995, which fights for scientific information on food and health), contains an interesting study on the importance of the distinction between absolute and relative risk.

Absolute risk is the difference between the disease rate of a risk category and that of a control group; the **relative**

risk, instead, is the relationship between the illness rate of a risk category and that of a control group. Relative risks, if not reported in the context of absolute risk, may be misleading.

Absolute risk data, on the other hand, is necessary to understand the implications of the relative risks and how specific factors or behaviours can influence, for example, the likelihood of developing a disease or a particular health status. In other words, the absolute risk measures the

clinical impact associated with exposure to a certain risk factor, the one related to the strength of the association. The infographic shows an example of treated meat consumption and the risk of bowel cancer. The **relative risk** of developing bowel cancer for those who eat less treated meat respect to those who eat more treated meat increased by 18%; when related to absolute risk, this involves a small increase, equal to 1%, from 5.6% to 6.6%.

ELEMENTS OF CANCER RISK IN MEAT

According to the IARC, the risk factors of meat are due to substances that may be particular to meat (e.g. heme iron), and/or originated during processing or cooking at high temperature (e.g. NOC nitrous compounds or HAA aromatic amines). These substances in the long run, when introduced into the organism, can be co-responsible for the development of forms of tumour due to different biochemical mechanisms. An example can be that of aromatic amines (HAA), genotoxic substances potentially capable of damaging genetic information inside a cell causing mutations and inducing changes in DNA. The suggestion of limiting the consumption of red meat is therefore accompanied by that of avoiding cooking with an open flame, such as the barbecue. For completeness it is useful to observe that this phenomenon is not typical of meat, but of the method of cooking: the same dangerous compounds, even if to a lesser extent, are formed in other foods, such as for example grilled vegetables or pizza cooked in a wood oven.

NITRATES AND NITRITES + HEME IRON + COOKING

Nitrosamines: are organic compounds containing a nitrous group, $-N = O$, bound

to the amino nitrogen. They are obtained in very acidic conditions or at high temperatures due to the reaction of the nitrites with a secondary amine, which may be present within a protein structure. Many nitrosamines are carcinogenic, i.e. provoke genetic mutation, as demonstrated by animal studies in laboratory; their intake is linked to the development of stomach and oesophagus cancer. The problem of nitrosamines is linked to the presence of nitrate as a natural component of food, convertible into nitrite in the mouth thanks to saliva, and to the use of nitrite as a food preservative, essential to prevent the development of micro-organisms in foods such as the botulinum bacterium. Nitrite finds optimal conditions to produce nitrosamines inside the stomach or through cooking methods such as frying or roasting.

Heme Iron: is found in meat in the form of haemoglobin and myoglobin. The heme iron is released by these proteins due to the low pH in the stomach and the action of proteolytic enzymes in the stomach and small intestine, to be then absorbed by the mucosa and transported in the blood directly to the cells to make haemoproteins. The negative

effects of very high amounts are cytotoxicity and increased formation of endogenous N-nitrous compounds (NOCs), which can increase the overall mutation rate in the DNA of the colon tissue.

Heterocyclic amines: form in meat and bread if they are burned, due to cooking at too high a temperature. In human populations an association between the ingestion of "burned" meat and the risk of cancer has not been identified. Probably it has a limited effect and is difficult to identify.

COOKING AND SMOKING

Polycyclic aromatic compounds: are formed after cooking at high temperatures and smoking. Although more than a hundred different PAHs exist, IARC (International Agency for Research on Cancer) has added to the lists those most dangerous or more responsible for serious damage to human health. Repeated exposure to certain types of PAHs has been shown to increase the onset of cancer significantly.

Not all meats are the same

Once clarified which substances are characterised by the greatest risk factors, it is advisable to analyse in-depth relative to their presence in the various cuts of the meat.

A first analysis is about nomenclature: it must be clarified what is meant by red and processed meat. In traditional culinary terminology, meat is conventionally classified as “red” when characterised by a typical red colour, while “white” usually defines a sub-type with a lighter colour. Although the semantic debate is still open, the first type defines “red” as the meat of the majority of large mammals (cattle, pigs, sheep, goats, horses) while the “white” type identifies poultry (chicken, turkey) and rabbit.

One of these substances, **heme iron**, is characterised by a marked variability both between red and white meat and between groups of red meats.

Nitrites, another critical substance, is mainly contained in processed meats (where they play the **role of preservative**), but also in other **foods**. Fresh vegetables, for example, contain high amounts of nitrates, which can be turned into nitrites. It should be remembered that most PDO cured meats are free of these substances⁹⁹.

As for **aromatic amines (HAA)**, their presence is strictly related to cooking methods: the data published in the EPIC study observed in fact the change in the content of the main substances between fresh meat (with zero value) and cooked meat in various ways. In this context, **communication to consumers should recommend a change in meat cooking methods**, rather than a general reduction in consumption¹⁰⁰. Finally, for **polycyclic aromatic**

hydrocarbons, the 2004 EFSA opinion indicates that indicates that the two major contributions to **dietary exposure are cereals, products derived from cereals, and seafood** and their derivatives. For these substances it is also important to observe how **in smokers the contribution of the diet is almost zero compared to that of the smoke**.

MEAT TYPE	CUT	FE TOT	FE HEME
 BEEF	Fillet steak	2.3	2.1
	Roast beef	2.0	1.8
	Rump	1.9	1.7
 SHEEP	Sheep thigh	2.2	1.7
	Lamb thigh	0.9	0.4
 PORK	Loin	0.4	0.2
	Steak	0.5	0.3
 POULTRY	Breast convent.	0.4	0.1
	Thigh convent.	0.7	0.2
	Bio breast	0.6	0.3
	Bio thigh	1.0	0.5

Presence of Iron and Heme Iron in meats. Data in mg/100 grams. Source: Lombardi-Boccia G. et al., 2004¹⁰¹ - Mele M. et al., 2015¹⁰²

NITRATES AND NITRITES: THE HIGHEST CONCENTRATIONS ARE IN VEGETABLES					
mg/100g	NITRATES	NITRITES	mg/100g	NITRATES	NITRITES
Beetroot	329	0.60	Raw ham PDO	0	0
Celery	315	0.08	National raw ham	0	0
Radishes	258	0.48	Choice cooked ham	6	5
Spinach	247	0.38	Bacon	21	0
Lettuce	233	0.06	Frankfurter of pure pork	13	0
Beets	203	0.13	Zampone Modena PGI	0	7
			Sausages PDO	1.4	0

Presence of nitrates and nitrites in some foods. Data in mg/100 grams. From: food content of potentially carcinogenic substances¹⁰³

THE FOOD CONTENT OF POTENTIALLY CARCINOGENIC SUBSTANCES	PHLP (ng/g)	MELQX (ng/g)	DIMELQX (ng/g)	AC (ng/g)	IQ (ng/g)	MELQ (ng/g)
Fresh beef	0	0	0	0	0	0
Beef grilled (rare)	0-1.2	0-1.1	0	0	0	0
Beef grilled (well cooked)	0-15.0	0-2.2	0-4.3	0-4.15	0	0
Beef grilled (very cooked)	5.7-33.3	1.2-5.8	0.4-1.9	0	0	0
Fried beef	0-23.2	0-8.2	0.1-1.3	0	0-2	0-1.7
Hamburger	0.2-18.4	0.2-1.8	0-0.1	0	0	0
Pork meat (fried or grilled)	0-7.8	0-3.8	0-1.1	0	0-0.7	0-0.1
Chicken meat (fried or grilled)	0-270	0-9	0-4	0-170	0	0
Bacon	0-46.2	0-23.7	0-3.4	0-0.1	0-10.5	0-1.7
Frankfurters	0-0.6	0-0.7	0-0.2	0	0-0.2	0-0.1

Data in ng/100 grams. From: food content of potentially carcinogenic substances¹⁰⁴

Protective effect of a balanced diet: vitamin C, vitamin D, folic acid

The analysis of all this data, which doesn't identify in a clear way a "good" and a "bad", confirm once again that a diet should be considered as a whole and that **the correlation of causes and effects is very difficult, when referring to a single food**

or food substance. Some studies have recognised the protective role¹⁰⁵ of calcium, milk or whole grains, often associated with a lower risk of colorectal cancer, and there is substantial evidence for the potential chemo preventive effects of **vitamin D, folic acid**, fruit and vegetables, also because of their **vitamin C** content.

FOOD	PREPARATION	TOTAL PAH (µg/kg)
Beetroot	raw	14
Cauliflower	raw	2.8
Lettuce	raw	2.6
Courgette	raw	8.9
Apple	raw	8.3
Oatmeal bread	oven	64
White bread	oven	3.2
Breakfast cereals	dried	5.7-59.5
Cereal flour	dried	8.6-38
Pizza	oven	13
Bacon	smoked	6.8
Beef	smoked	9.7
Beef	barbecue	5.7-42.1
Chicken	barbecue	0.6-60.2
Ham	smoked	2.6-9.5
Pork meat	barbecue	3.1-13.6
Salmon	smoked	86.6
Herring	smoked	55-180

*Content of polycyclic aromatic hydrocarbons. Data in µg per kg.
Source: Food content of potential carcinogens, EPIC, 2004.*

Suggestions

It is clear that every food, including water, every nutrient or food substance presents actual, presumed or potential risks closely related to the quantities consumed, the individual and lifestyle. Meat has high nutritional qualities and its consumption in moderate quantities is linked to proven and consolidated benefits over thousands of years. The benefits and risks associated with the consumption of red and processed meat should not cause dilemmas, if these meats are consumed in moderate quantities as part of a balanced diet¹⁰⁶. On the basis of apparent consumption data currently available (FAO and Ismea), on average Italians consume 237 g per day of all types of meat (chicken, pig, bovine, ovine-caprine). **The real consumption pro capita corresponds instead to less than half, or 104 g per day of meat**, equal to 728 g per week and 38 kg per year. This consumption includes all meat, regardless of how (raw, cooked, transformed into cured meats, present in mixed food preparations, canned, etc.) and where (home, restaurants, fast food, canteens, communities, stalls, etc.) it is consumed. Considering only **the consumption of red meat (beef and pork) and cured meats (thus excluding white meat), the actual consumption stands at 69 g per day, with regard on the other hand to only beef, real consumption drops to 24.8 g per day per capita**, well below the 100 g per day as indicated by WHO/IARC as a risk threshold for cancer diseases¹⁰⁷. There is, of course, considerable variability around these values and suggestions of consumption reduction are orientated especially if processed meat consumption is high. However, there remains considerable uncertainty about the risks associated with specific types of red meat (e.g. pork and beef) and processed meat and, in fact, on which

meat to consider processed¹⁰⁸. It is risky to give credit to information which, on the basis of a hypothesis of risk of a minimum increase in the probability of a disease (such as cancer) leads to **a specific risk of nutritional deficiencies and to the known effects that result at metabolic and cognitive level**. These considerations have an even greater value when they concern the diet of growing individuals, that in subjects of old age or with particular health conditions.

The opinion of the CNSA

The National Committee on Food Safety (CNSA) has made clarity on the IARC report about meat and cancer, sustaining that:

(...) meat is an important source of high biological value proteins, amino acids, vitamins, minerals and metals (in particular iron and zinc) in human nutrition and, above all, in certain age groups and/or physiological states, as well as in particular health conditions; (...)

and also,

(...) that colorectal cancer, like all neoplasms, is the result of several factors and is triggered by the interaction between environment, lifestyle and genetics; which, in this general framework, are particularly relevant: weight excess, sedentary lifestyle, low fibre consumption, excess calories in the diet, lifestyle as a whole, including food (...)

and it is recommended

(...) to follow a varied diet, inspired by the Mediterranean model, avoiding excessive consumption of red meat, both fresh and processed (...) avoiding the excessive consumption of each food".

(Source: www.salute.gov.it/imgs/C_17_pubblicazioni_2473_allegato.pdf)

5 IS MEAT CONSUMPTION SUSTAINABLE?

The starting point for assessing whether people's food consumption is consistent with the guidelines suggested by nutritionists is to quantify the consumption data per capita per year. Scientific literature offers a lot of information in regard, that however has a limited usefulness due to the many variables in terms of in-depth detail and the boundaries of the analysed phenomena. The following however is a proposed analysis that, although preliminary, provides some interesting information on the consumption of meat and cured meats.

5.1 How people's food consumption is estimated

In general, food consumption can be estimated using two different approaches: the calculation of **food availability** and the **detection** of real consumption.

Availability of food (apparent consumption)

The first method is to estimate a very general picture of the food resources available for human consumption in a country in a given period of time, to the point that its monitoring is normally carried out by major institutional sources (ISTAT, Eurostat, FAO...) showing the relationship between food availability in a country and the number of inhabitants accessing available resources. In the case of meat, the data is given in **equivalent carcass**

$$\frac{(\text{production} + \text{import} + \text{initial provisions}) - (\text{non-food use} + \text{export} + \text{final provisions})}{\text{number of inhabitants of the country}}$$

weight which, including non-edible parts (tendons, bones, fat, ligaments), tends to overestimate the real consumption: in this case it is **apparent consumption**. By their nature, this information should not be used to study the relationship between food and consumer health, unless it accepts the enormous overestimation of real meat consumption.

Real consumption

Real consumption is estimated by surveying families or people through specific surveys of well-defined population samples. Although for simplicity in this work the two methods are assimilated, in truth the survey on families is normally conducted analysing the economic expenditure of a given period of time through interviews, while that on individuals involves just the consumption of a given food by a specific sample of people over a given period of time. These methods are used by organisations specialised in the analysis of statistical data, such as INRAN, Nielsen, Eurisko, or by scientific studies as in the case of the *European Prospective Investigation into Cancer and Nutrition* (EPIC) project. They are ideal for the acquisition of information useful for the study of the relationship between eating habits and health of people, but they have the defect of being very expensive.

	APPARENT CONSUMPTION	REAL CONSUMPTION	
	FOOD AVAILABILITY (APPARENT CONSUMPTION)	MONITORING FAMILY EXPENDITURE	INDIVIDUAL CONSUMPTION
MODE	Mathematical relationship between quantity of available food and inhabitants	Detection of expenditure (and sometimes quantity) for the purchase of food by families	Detection of individual or group consumption in 24 hours or in longer periods by diary or interviews
TARGET	Know the amount of food available in a country Compare trends and consumption amongst various countries Orient decisions on agri-food policies	Analyse food spending by various sampling of people Monitor food consumption over time	Evaluate per capita consumption of food Studying the relationship between diet and health
CRITICAL ISSUES	Does not include production for self-consumption Includes non-edible parts Difficulty in estimating quantities destined for non-food uses Includes losses in the different stages of the supply chain In calculating people, it does not take into account the balance of the flow of tourists as well as non-resident immigrants	Detects the expense and not the quantity purchased Does not estimate eating meals outside the home There is no distinction between the moment of purchase and the moment of consumption Methodological aspects related to sampling	The detection can consider weights or number of portions as well as raw or cooked weight Considers with difficulty waste in the plate Preparations with different types of ingredients (e.g. meat and vegetables) Methodological aspects related to sampling Participant reliability Cost of the method

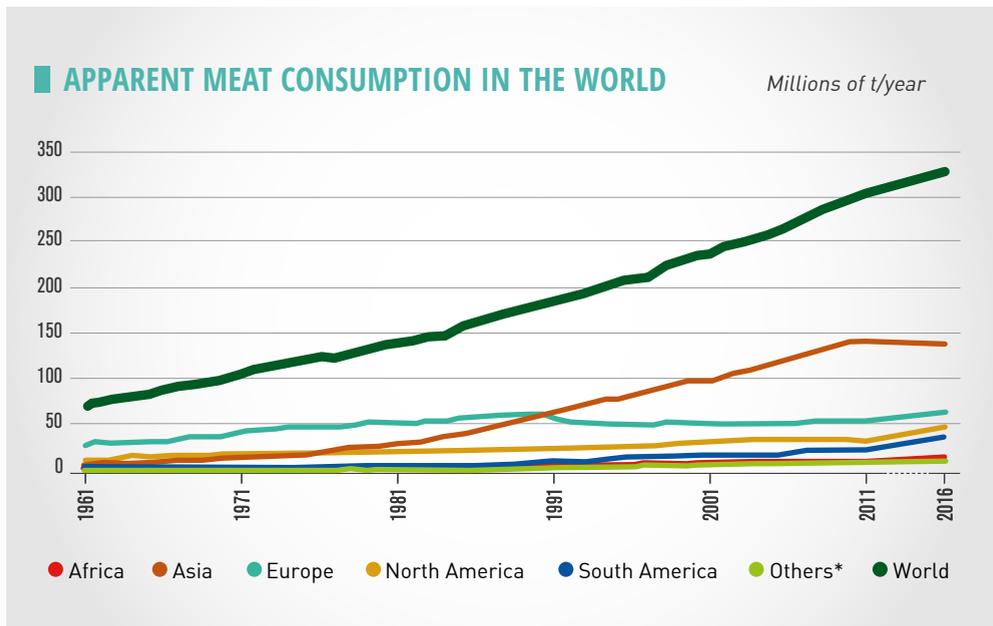


5.2 The consumption of meat in the world

In 2016, the world's theoretical meat supply reached about 330 million tons per year, of which just over 40% in the Asian continent only. Which, since the early nineties, has contributed more to the growth of the volumes. Europe and North America contribute in a more limited way, with values that measure respectively 19% and 15%. The most consumed species are pork, chicken and beef, although with different annual trends: consumption of beef has been substantially stable for over 20 years, while over the same period the consumption of poultry meat has almost doubled. Albeit with some differences between the various species, there is no doubt that the consumption

of meat has undergone, over the last 30 years, a clear increase at global level, an increase referring also to the increase in the world population, from about 3 billion in 1960 to the current 7.5 billion. However, it is worthwhile focusing on the individual regions of the world to see how and where people's eating habits have changed over time. To do this, the theoretical availability data per capita in the same areas already studied are analysed. Also in this case there are substantial differences between the various regions of the world: the countries of North America, in fact, register an apparent consumption much higher than that of other continents.

Asian countries, which have become the first global consumers in terms of volume, are in fact amongst those with a



Source: FAOSTAT www.faostat3.fao.org/home/Ee

* Oceania and Central America

lower per capita value, even if they have grown substantially since the end of the 1980s.

Too much meat or too much imbalance between the Countries of the world?

The analysis of world consumption data, but above all their variability from region to region, leads to the consideration that the direct correlation between meat consumption and sustainability is always very critical, without this being contextualised.

Statements such as “**eating too much meat**” or “**meat consumption is unsustainable**” should be contextualised in the light of such data, to understand if this is true at all or if it is more true in some

parts of the world. Obviously this work offers only a preliminary vision of the problem, which could be explored with a more detailed analysis.

However, it seems clear enough that:

- meat consumption is increasing both due to the higher per capita consumption in some areas of the world, and (and above all) to the **increase of the global population**;
- here is a strong imbalance between regions of the world: the meat consumption per capita in North America is more than 4 times higher than the average African one;
- consumption of **beef in Europe does not show substantial increases since the end of the 1990s**.

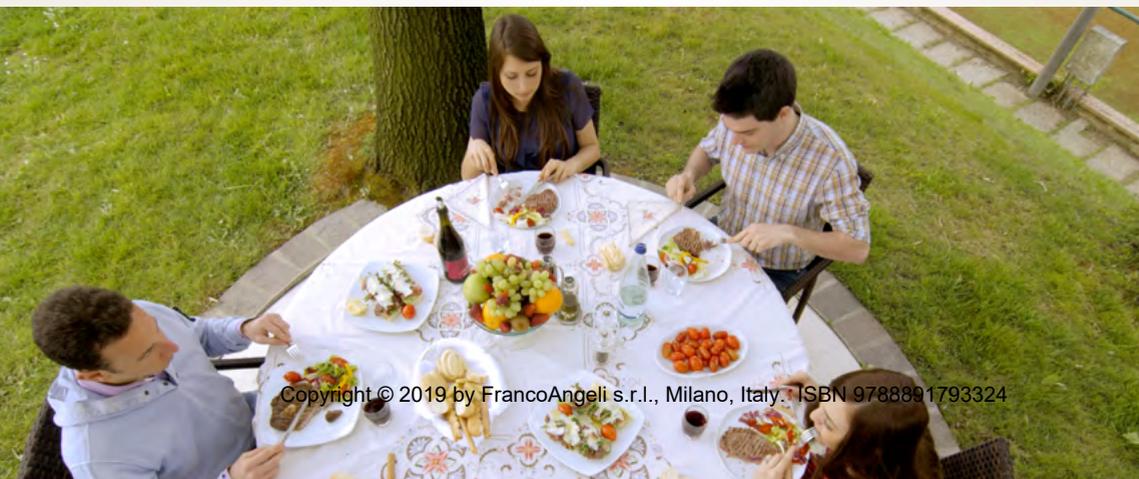
DATA SOURCE USED

The analysis presented in this part of the document were realised taking into consideration the data published on the FA-OSTAT database, available on the website www.faostat3.fao.org/home/Ee which refer to **apparent consumption**, having

been processed using the *food balance sheet*.

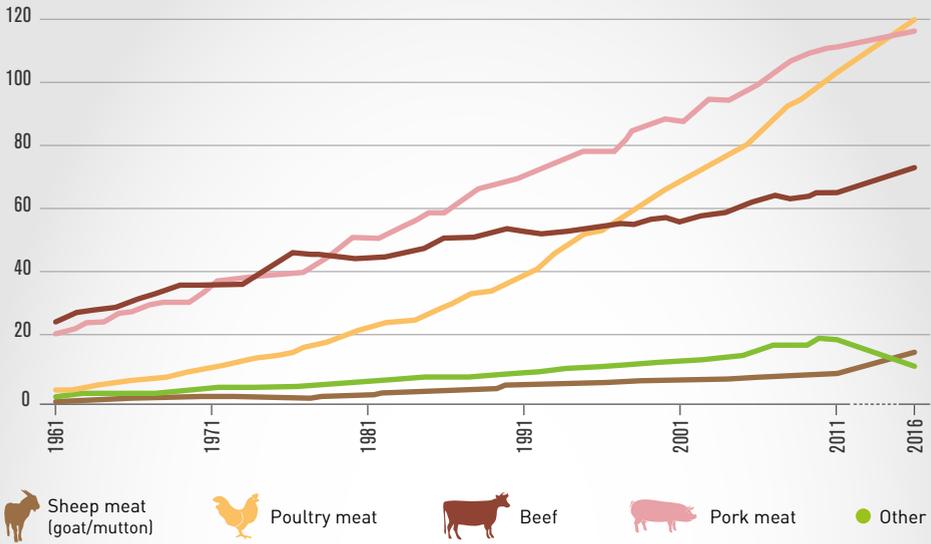
The interrogations were performed in August 2018 with the following characteristics:

- annual coverage from 1961 up to 2016;
- types of products included in the total meat item: *Bovine Meat - Meat, Other - Mutton & Goat Meat - Offals, Edible - Pork meat - Poultry Meat*;
- in the “other” regions, Oceania and Central America were included.



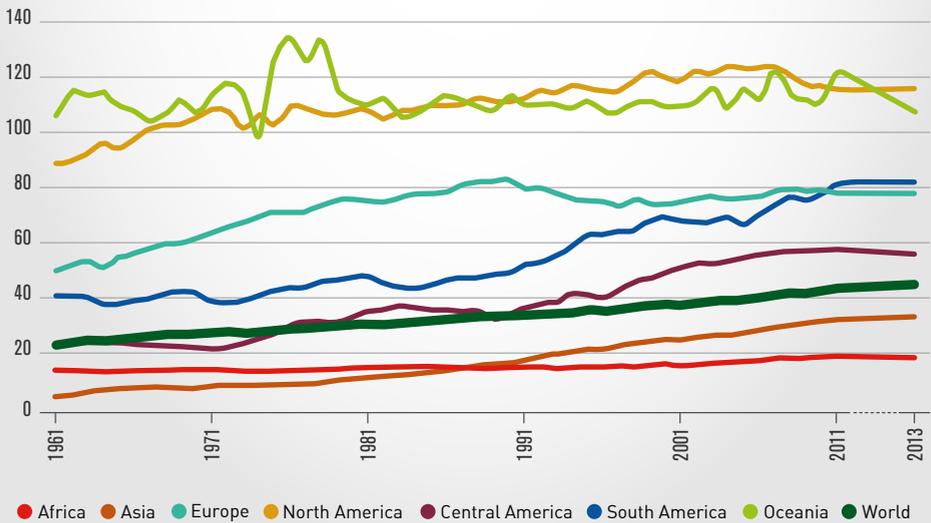
APPARENT MEAT CONSUMPTION PER SPECIES IN THE WORLD

Millions of t/year



APPARENT MEAT CONSUMPTION PER CAPITA

kg per capita per year



Source: FAOSTAT www.faostat3.fao.org/home/Ee

FOOD DIETS IN THE WORLD: A COOP - DOXA REVELATION

Among the projects published in the period of EXPO 2015, an interesting study was found conducted by DOXA for COOP Italy aimed at studying what could be the evolution of the food sector. From the analysis, available on the DOXA 109 website, an estimate of average food consumption in some countries has also emerged.

Even if the evaluation is to be considered preliminary because it shows the frequencies of consumption and not the quantities, it is very interesting to observe how Italy has a consumption



lower than average for animal proteins, and therefore also for meat, and higher for that which concerns carbohydrates, sweets, fruit and veg-

etables. The main consumers of meat among the analysed countries are Russia, China and Brazil. Italy is the lowest consumer of meat after India.

The diets of the world

In Italy "**Mediterranean Diet**", high **meat** consumption in Russia, China and Brazil, mainly **protein** diet for Germany, UK and USA

Average weekly consumption in days		Italy	Germany	UK	USA	Russia	China	India	Brazil
4.7	Carbohydrates	5.2	3.8	3.9	3.7	4.1	5.9	5.4	5.8
4.0	Meat	3.4	3.9	3.7	3.9	4.8	4.6	2.6	4.7
1.7	Fish	1.6	1.2	1.5	1.5	1.8	2.6	2.4	1.4
3.6	Cheese and dairy products	3.0	4.4	3.3	4.0	4.0	3.6	2.9	3.9
2.6	Eggs	1.5	2.1	2.1	2.6	2.7	4.2	3.0	2.6
4.6	Fruit	5.1	4.7	4.5	4.0	4.1	4.8	4.9	4.3
4.9	Vegetables	4.9	4.4	4.8	4.5	4.6	5.8	5.5	4.7
4.0	Sweets	4.2	3.5	3.5	3.7	5.3	2.8	4.2	4.8

5.3 Consumption of meat in Italy

As for consumption in Italy, it was decided to compare the apparent consumption data, available in the FAO database already consulted, with those of real consumption.

To this end, various public sources mentioned in the bibliography were analysed. Despite being rather complex to identify a univocal data of **real or apparent**

consumption, the results allow to make some general considerations. Going into detail on the data analysed, we can see that the apparent consumption value is around 232 g of meat per capita per day, while that of real consumption is about 103 grams.

This difference is also consistent with the average yield data between edible meat and animal carcasses.

DATA SOURCE USED



APPARENT CONSUMPTION

- **FAOSTAT**
Database already described for the analysis of world consumption. The data presented is relative to 2016
- **ISMEA**
The data is part of a historical series from 1938 to 2009 elaborated by the Milan Chamber of Commerce in 2010. In this analysis the most recent available data was taken into consideration¹¹⁰.
- **GIRA**
Data disseminated by the main statistical research institutes



REAL CONSUMPTION

- **INRAN**
The data presented is the average of 4 scientific studies conducted by CSPO¹¹¹, EPIC¹¹², INRAN¹¹³ (now CREA - Food and Nutrition)
- **GFK Eurisko**
The basic data used in this work are those of the Ismea-Gfk-Eurisko database from periodic surveys on purchase behaviour of a sample of 8000 families. Consumption outside the home is not included. The study is cited in the ISMEA document
- **ASPAs**
Scientific study of the Association for Science and Animal Production (ASPAs)



FROM APPARENT CONSUMPTION TO REAL CONSUMPTION THE ASPA STUDY

ASPA, Association for Science and Animal Production, was founded with the aim of promoting the progress of the science and technology that affects livestock production with all the factors of sustainability concerned. Many Italian academic organisations are members of the association who, for their different skills, have the objective of carrying out scientific studies useful for the purpose¹⁴.

One of the ASPA projects led to the finalisation of a sys-

tem for the estimation of real meat consumption in Italy: thanks to the in-depth study of all the livestock production chains, the objective of the research was to **publish conversion coefficients useful for transforming the data related to the availability of meat products (apparent consumption) in real consumption by consumers.**

In the book "Real consumption of meat and fish in Italy"¹⁵, published in 2016, the

results of the full study are reported, based on practical analysis and field surveys, specific surveys, interviews with operators. The great advantage of the method proposed was to arrive at the estimate of the actual consumption of meat with a precision comparable to that of a survey on individual consumption, avoiding the high costs of the latter.

Starting from the apparent availability data and using

CONVERSION COEFFICIENTS OF THE CARCASSES OF DIFFERENT ANIMAL SPECIES IN SELLABLE MEAT

SPECIES AND CATEGORY (RED MEAT)	CONVERSION COEFFICIENT (K)	SPECIES AND CATEGORY (WHITE MEAT)	CONVERSION COEFFICIENT (K)
Calves	0.524	Chicken meat <2kg	0.610
Male bullocks	0.593	Chicken meat >2kg	0.620
Female bullocks	0.575	Turkeys	0.621
Cows	0.507	Guinea fowls	0.582
Piglets	0.494	Ducks	0.520
Light pigs	0.528	Geese	0.520
Heavy pigs	0.492	Quails	0.452
Baby lamb	0.573	Rabbits	0.553
Adult lamb	0.536		
Kids and goats	0.526		

Source: Russo V. et al., 2016. Conversion coefficients (K) of the carcasses of the various species in consumable meat. Tab. 1, p. 49

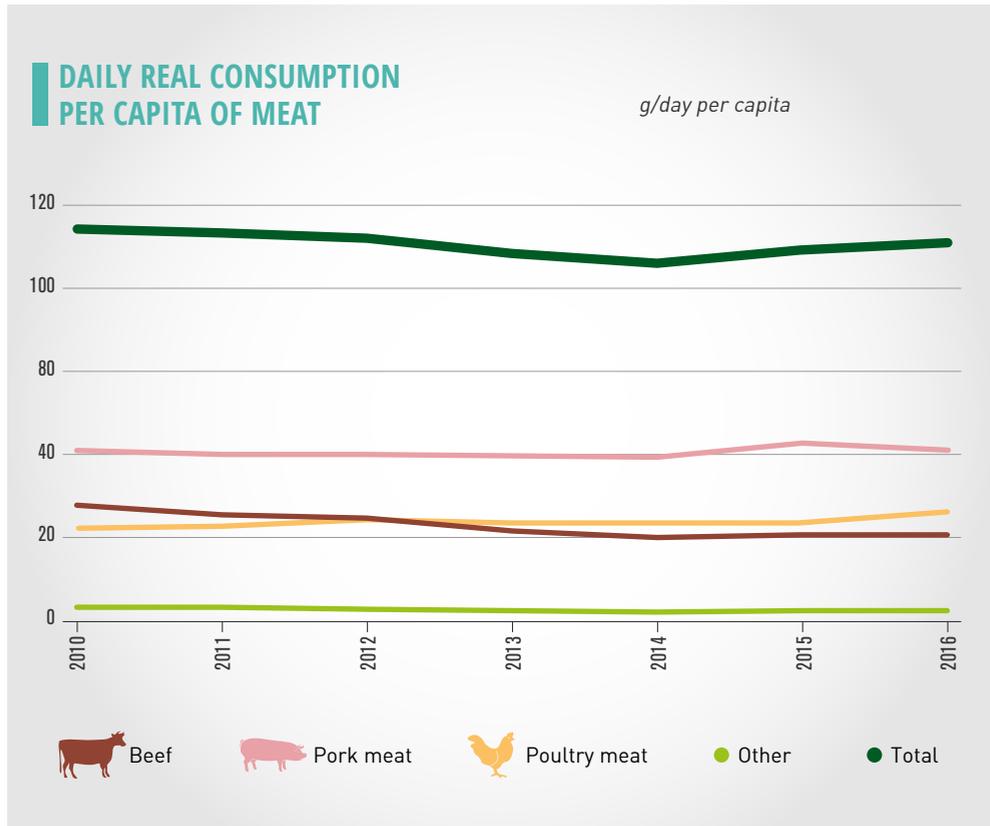
the conversion factors resulting from the study of the working group led by prof.

Vincenzo Russo, it was possible to calculate the real consumption data, estimating

the edible part with respect to the carcass of the single animal species.

ANNUAL CONSUMPTION PRO CAPITA OF APPARENT ¹¹⁶ AND REAL MEAT IN ITALY					
MEAT TYPE	APPARENT CONSUMPTION	CONSUMABLE MEAT	REAL CONSUMPTION	CONSUMABLE ON APPARENT (%)	REAL CONSUMPTION ON APPARENT (%)
BOVINE 					
2010	23.8	13.6	12.0	57.1	50.5
2011	22.1	12.6	11.1	56.9	50.4
2012	21.3	12.2	10.8	57.2	50.6
2013	20.2	10.9	9.6	N.C.	N.C.
2014	19.6	9.6	8.5	N.C.	N.C.
2015	17.6	10.2	9.0	57.9	51.0
AVERAGE	20.8	11.5	10.2	57.3	50.6
PORK 					
2010	38.4	20.2	17.8	52.6	46.3
2011	37.3	19.8	17.4	53.1	46.7
2012	36.9	19.5	17.2	52.8	46.7
2013	36.7	19.5	17.2	53.1	46.8
2014	36.4	19.5	17.2	53.6	47.3
2015	39.0	20.7	18.3	53.1	46.9
AVERAGE	37.4	19.9	17.5	53.0	46.8
POULTRY 					
2010	18.0	10.9	9.6	60.6	53.4
2011	18.6	11.6	10.2	62.3	54.8
2012	19.4	12.1	10.6	62.4	54.6
2013	18.8	11.6	10.2	61.7	54.2
2014	19.5	11.8	10.3	60.5	52.8
2015	19.9	11.7	10.3	58.7	51.7
AVERAGE	19.0	11.6	10.2	61.0	53.6

Source: Russo V. et al., 2016. Apparent consumption (ISMEA), availability of consumable meat and real consumption of beef, pork and poultry (kg per capita/year). Tab. 5-6-7, pp. 55-56

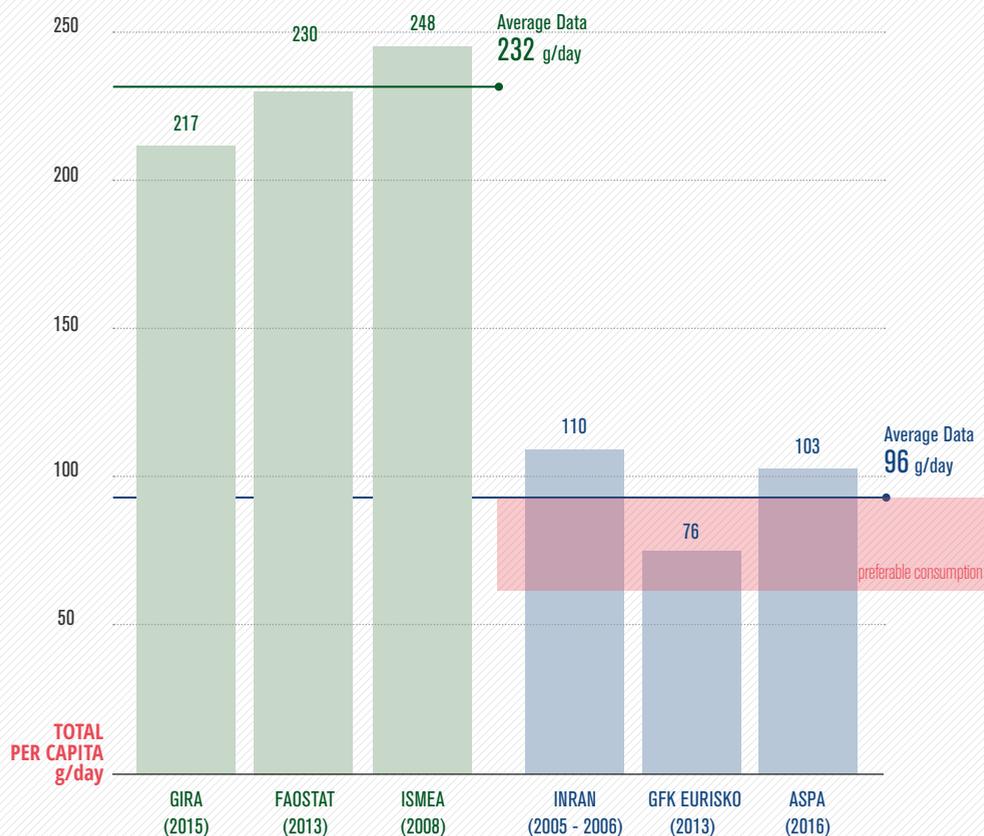


Source: Russo V. et al., 2016. Apparent and actual daily consumption (g) of total meat and the main species in the sexennial 2010-2015. Tab. 10, p. 60





CONSUMPTION OF MEAT AND CURED MEATS IN ITALY



APPARENT CONSUMPTION

Estimated from production data for macro-economic evaluations. It cannot be used for nutritional considerations.



REAL CONSUMPTION

Based on surveys involving consumers for the purpose of assessing nutritional habits.

FREQUENTLY ASKED QUESTIONS

THE MEDITERRANEAN DIET INCLUDES MEAT CONSUMPTION?

Yes. The Mediterranean Diet is very varied, and includes balanced quantities of each type of food. In general, what emerges from the Mediterranean model is a style of eating with a high consumption of vegetables, legumes, fruit and nuts, olive oil and cereals (possibly wholegrain), and a moderate consumption of fish, meat, dairy products (especially cheese and yogurt) and desserts.

Meat is also therefore part of the Mediterranean Diet. In fact, in the past, in addition to fish, game, various courtyard animals (chickens, turkeys, rabbits, geese, etc.) and pigs were consumed, the feeding of which was based on the use of agricultural by-products and human food waste. The slaughter was done directly by the owners of the animals, which, if large (pigs and cattle in particular), made it necessary the preservation of the meat in order for it to be used in subsequent periods.

This necessity has allowed us to “give rise to” numerous cured meats, which have become today a pride of our food production and appreciated all over the world.

Suffice it to say that out of 244 Italian PDO and PGI products, 1/3 comes from breeding production and 37 are part of the meat cate-

gory, such as bresaola, ham, culatello, cured meats, mortadella, cotechino, bacon, coppa, lard etc.

ACCORDING TO MODERN BIOMEDICAL SCIENCE THE MEDITERRANEAN DIET REPRESENTS THE BEST WAY OF EATING AND REPRESENTS A TRUE STYLE OF LIFE. WHY?

The international scientific community has accepted the role of the Mediterranean Diet in increasing life expectancy and improving general health, and has contributed to the spread of this dietary model as a central pillar of public health programs and policies in many countries, from the United States to Europe.

But the Mediterranean Diet is not just a diet, it represents a way of life. The “Mediterranean Diet Foundation” has developed a graph of the Food Pyramid, which includes information closely related to the Mediterranean cultural and social lifestyle, as well as the importance of physical exercise and conviviality.

The importance of Mediterranean **life** is highlighted in the Pyramid, including factors not related to the use of particular foods. It is a global approach: not a single food, not a single behaviour, but a lifestyle that requires regular physical activity, adequate rest, conviviality and different

products to be consumed following seasonality.

WHY IS THE PRESENCE OF ANIMAL PROTEINS IMPORTANT IN A BALANCED DIET? WHAT BENEFITS DOES THE ORGANISM DERIVE FROM MEAT CONSUMPTION? HOW MUCH CONSUMPTION OF MEAT IS RECOMMENDED?

Just as the Mediterranean Diet shows, it is necessary to follow a varied and balanced diet for health and physical well-being. This “diet” should include not only fruit and vegetables, but also a moderate consumption of meat, a food capable of bringing numerous benefits to the body.

A proper consumption of meat, especially of lean cuts, can be beneficial at different stages of life. Like during growth and adolescence, when boys and girls are more in need of proteins and must avoid the risk of **iron** deficiency anaemia.

Even during pregnancy, one of the times when increased nutrient requirements are greatest, the intake of meat (in this case well cooked) is very important. Or again during the paediatric age, another period of life when there is continuous growth, the needs of proteins are very high, and these are used by the body for fabric construction. During old age, the assumption

of proteins can no longer be underestimated. An inadequate intake of protein in an elderly person, in fact, contributes to increase skin fragility, reduces the body's ability to recover and its immune functions, causing difficulty and prolonging the time for healing from illnesses. Always accompanied by abundant quantities of fruit and vegetables, the right amount of food of animal origin allows in every phase of life to increase the intake of vitamins of groups B, A and D and of mineral salts such as calcium, iron and iodine. Compared to a meat-free diet, a diet that includes lean cuts contributes to a better intake of protein, selenium, thiamine and vitamin B6, without increasing the intake of total and saturated fat.

Not only that, unlike food based on fats and carbohydrates, it has a **high satiating effect**. The anti-hunger effect is due to the blocking of ghrelin, the hormone that stimulates hunger, caused by the digestion of proteins.

WHAT ARE THE HEALTH BENEFITS OF THE MEDITERRANEAN FOOD MODEL?

It reduces the risk of metabolic syndrome and chronic diseases, as well as cardiovascular risks.

Scientists have compared the risk of developing heart disease and other diseases in populations that have and have not adopted the Mediterranean Diet. The latter is linked to:

- increase in longevity, i.e. a reduced possibility of death at any age, mainly because of the reduced chances of developing, having a recurrence or dying of heart disease or due to cancer. The results were confirmed in the populations of the United States and United Kingdom, with a 20% reduction in the risk of death at all ages: reduced risk of developing diabetes 2, hypertension or increased blood cholesterol, each of which is associated with heart and vascular disease;

- reduction of the possibility of becoming obese: the Mediterranean Diet has formed the basis for a balanced weight reduction; reduction of the risk of developing Parkinson's disease and Alzheimer's disease.

IS EATING MEAT DANGEROUS FOR HUMAN HEALTH?

A moderate consumption of animal proteins is indeed not dangerous for human health. In contrast, excessive consumption of red meat, exceeding 500 g per week, is associated with an increased risk of developing diabetes, cardiovascular disease and cancer. According to studies by the Italian Association for Cancer Research, "no pathology is caused solely by the consumption of meat, and there is no direct and absolute cause and effect relationship between consumption of animal proteins and the development of a given disease. [...]"

There are no studies to suggest a convincing relationship

between the risk of disease and a low consumption of animal proteins; indeed, in some cases a limited intake of animal proteins has beneficial effects, because it provides important micronutrients". The value of 500 grams is however higher than what is suggested in the nutritional claims related to the Mediterranean diet.

IF THERE IS NO DANGER FOR HEALTH, WHY HAS IARC (INTERNATIONAL AGENCY FOR CANCER RESEARCH, THE RESEARCH AGENCY OF THE WORLD HEALTH ORGANISATION) CLASSIFIED RED AND TRANSFORMED MEATS RESPECTIVELY AS PROBABLY CARCINOGENIC AND CARCINOGENIC FOR MANKIND?

The IARC in 2015 anticipated the decision to include processed meat in Group 1 (carcinogenic) and red meat in Group 2A (probably carcinogenic), based on many scientific studies, the results of which have been known for some time.

"In the studies examined, consumption of processed meats was associated with a small increase in cancer risk. In these studies, the risk generally increases with the amount of meat consumed. Analysis of data from 10 studies estimates that each 50g portion of processed meat, consumed every day, increases the risk of colorectal cancer by about 18%. The risk of cancer related to **consumption of red meat is more difficult to estimate**, because the proof

that red meat causes cancer is not so strong. However, if the association between red meat and colon-rectal cancer has been shown to be causal, data from the same studies suggest that the risk of colorectal cancer could increase by 1% in absolute terms (18% in relative terms) for each portion of 100 g of red meat eaten every day” (source: Q & A IARC site).

As we can see, IARC refers to elevated daily portions, very far from real consumption.

WHAT IS IN RED AND PROCESSED MEAT THAT INCREASES THE RISK?

According to IARC studies, the risk factors of meat are due to substances that may be proper to meat (e.g. heme iron), or **substances originating during processing or cooking at high temperature** (e.g. nitrous compounds or aromatic amines). The suggestion to limit the consumption of red meat is therefore accompanied by that of avoiding cooking with an open flame, such as the barbecue, and **adding food containing vitamin C, which not only facilitates the absorption of free iron present in red meat, but almost completely neutralises the risks related to potentially harmful substances.**

The presence of nitrous compounds or aromatic amines is considered responsible for the activation of carcinogenic mechanisms when the consumption of meat and cured meats is very high: for red meat we speak of over 100 g per day, while for processed

meat of 50 g day, values very distant from actual Italian consumption. For completeness it is beneficial to observe that this phenomenon is not typical of meat, but of the cooking method: the same caution should in fact be used for other foods, such as grilled vegetables or pizza cooked in a wood oven.

CAN THE ADDITION OF NITRATES AND NITRITES IN CURED MEATS BE AVOIDED?

Nitrates and nitrites are used, in the quantities authorised by health authorities, to prevent the development of *Clostridium botulin* spores, which in turn produce a very dangerous, even fatal, toxin for humans. In reality it is important to remember how these substances are used when only strictly necessary: in products with long seasoning, typical of Italian gastronomic tradition, they are not present because it was discovered that the same conservation process is sufficient to eliminate all risk and to preserve the meat's colour. In some products, such as PDO hams, the use of these substances is even prohibited. For the products in which they are used, the nutritional analyses of 2011, compared to those of 1993, showed decreases between 50% and 90% of nitrates (present however in a few parts per million).

CAN THE METHODS OF COOKING MEAT CHANGE THE RISK?

High temperature cooking

methods can generate compounds that could contribute to the carcinogenic risk, but their role is not yet fully understood. In particular, cooking at high temperatures or with food in direct contact with a flame or hot surfaces, such as barbecues or frying, produces different types of carcinogenic chemicals, such as polycyclic aromatic hydrocarbons and heterocyclic aromatic amines. However, it should be noted that this phenomenon is independent from the type of food and also concerns the carbonisation of other foods such as fish, vegetables, pizza, etc.

SINCE TOBACCO SMOKE, ASBESTOS AND ALCOHOL ARE CLASSIFIED AS CANCEROGENES FOR HUMANS, DOES IT MEAN THAT PROCESSED MEAT IS CARCINOGENIC AS WELL?

No. Even if they are in the same category as tobacco smoke or asbestos because of cancer, this does not mean they are all equally dangerous. The IARC classifications describes the strength of an agent's scientific evidence to be a cause of cancer, rather than assessing its level of risk. In other words, it is important to know not only in what list a certain substance is, but what are the dosages and durations of exposure beyond which the risk becomes real and not just theoretical.

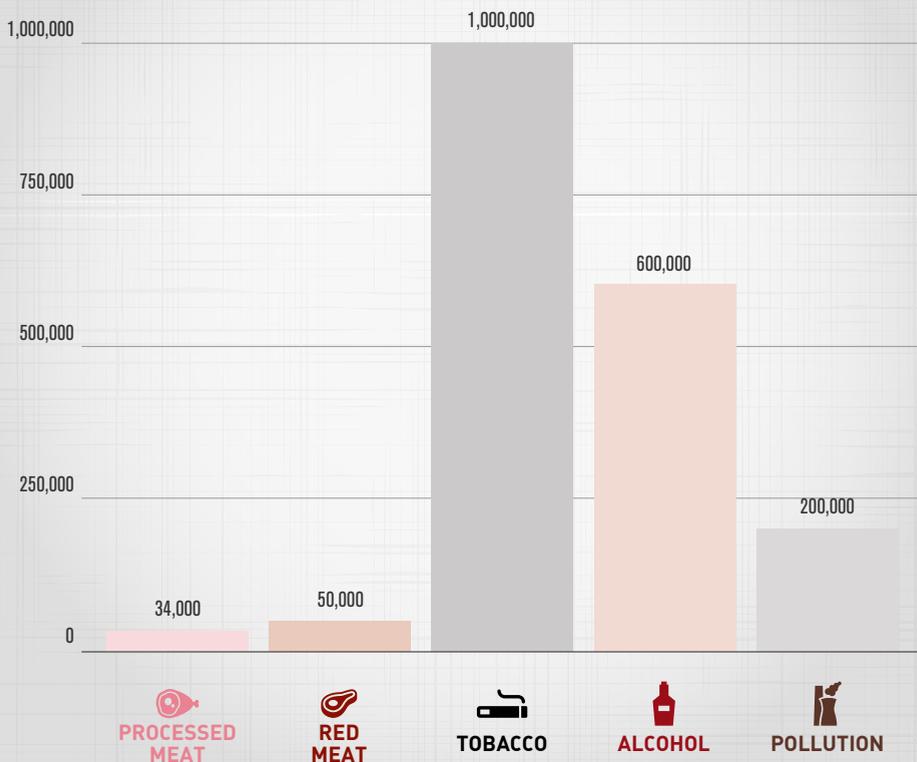
As the IARC explains, “according to most recent estimates of the Global Burden of Disease Project, an independent academic research organisation, about 34,000 cancer

deaths each year worldwide are attributable to diets rich in processed meats. Eating red meat has not yet been defined as a cause of cancer. However, if the association reports were proven to be caus-

al, the Global Burden of Disease Project estimated that diets rich in red meat could be responsible for 50,000 cancer deaths worldwide each year. These numbers contrast with about 1 million

cancer deaths due to tobacco smoking worldwide each year, 600,000 per year due to consumption of alcohol and more than 200,000 per year due to pollution" (Source: Q & A IARC site).

CANCER DEATHS PER YEAR AND EXPOSURE TO THE SUBSTANCE



Source: Global Burden of disease project (cited by the WHO)

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 - Doxa - Research and Analysis: www.doxa.it
 - Eufic - European Food information Council www.eufic.org
 - Food and Agriculture Organization of the United Nations: faostat3.fao.org
 - Institute for Health Metrics and Evaluation: www.healthdata.org
 - Institute for the Valorisation of Italian Cured Meats: www.salumi-italiani.it
 - Ministry of Health: www.salute.gov.it
 - Knowing how to eat, promotion of food culture: sapermangiare.mobi
 - Italian Society of Human Nutrition: www.sinu.it
 - United Nations Educational, Scientific and Cultural Organization: www.unesco.org



MEAT AND THE ENVIRONMENT

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- 🌱 WHAT ARE THE IMPACTS OF MEAT?
 - 🌱 HOW TO CALCULATE THE ENVIRONMENTAL SUSTAINABILITY OF FOOD
 - 🌱 THE ENVIRONMENTAL IMPACTS OF THE DIET: THE ENVIRONMENTAL HOURGLASS

Introduction

THE LIFE CYCLE ASSESSMENT METHODOLOGY (LCA) PERMITS THE CALCULATION OF THE ENVIRONMENTAL IMPACTS OF THE ENTIRE AGRI-FOOD CHAIN

THE EUROPEAN PRODUCTION SYSTEM HAS THE LOWEST ENVIRONMENTAL IMPACT PER KG OF PROTEIN

IF CONSUMED ACCORDING TO THE MEDITERRANEAN DIET MODEL, MEAT HAS AN ENVIRONMENTAL IMPACT SIMILAR TO THAT OF OTHER FOODS

*The debate on the impacts of food often leads to the timely comparison of environmental indicators related to the production of 1 kg of various foods. Whilst providing useful information for the improvement of supply chains, these classifications are not very significant for a few reasons. The first is nutritional: it is very clear, for example, that **the comparison between salad, rice and meat is wrong regardless because these foods have different “functions” and contribute to human health in a complementary way.** This was discussed in the nutrition chapter. In merit to the environmental reason, the classification of foods according to their impact can lead to the conclusion that the most impactful ones, such as meat, are to be eliminated so as to reduce the pressure on the environment. Even this consideration is not particularly consistent with reality because it suggests that some agricultural or livestock chains be cancelled.*

*On the other hand, those who know how agri-food production works have a clear mind about **the constant integrations between the various productions**, to the point that talking about different products is (almost) incorrect. Instead, it would be much more coherent to imagine food production as one big system, characterised by many products with as many by-products, that almost always find a use in the same sector **following the principles of the circular economy**, today very popular in the processing industry, but known to farmers and breeders for centuries. Entering the question of animal husbandry and the production of meat and cured meats, the debate should therefore not be regarding “if”, but on “how”, pushing the producers (agricultural and industrial) to constantly improve performances by reducing impacts. In this context, the calculation of impacts becomes a useful reference, facilitating comparisons with oneself or similar*

processes, provided that the indicators are interpreted correctly, avoiding misleading considerations such as those done by treating the overall consumption of water without referring to its availability in places of consumption.

*Lastly, further attention must be placed concerning the using of kg as a reference unit. There is no doubt that meats and cold cuts are among the foods characterised by the greatest environmental impact when the analysis is carried out per kg of product. Considering that a correct diet involves the balanced consumption of all foods, a correct analysis should take into consideration **the frequency of consumption and portions suggested by nutritionists**: the multiplication of impacts and quantities is the basis of the **Environmental Hourglass**, icon of the Sustainable Meat project. According to this representation, **eating meat in the right quantity does not result in a significant increase in an individual's environmental impact.***

1

WHAT ARE THE IMPACTS OF MEAT

1.1 Animals and plants: a circular system

Respect to other industrial sectors, the agri-food sector is certainly the most complex, because it is conditioned by **the many interactions between the various production chains** that are substantially integrated into a model defined as **circular**. This term, used not offhand, has become “trendy” again in recent years. One of the main challenges for the sustainability of industrial systems is that of modifying the linear growth model (extraction of raw materials, transformation and disposal of waste) to circular, thus maximising the reuse and recovery of waste. One of the most current definitions of circular economy is from the Ellen MacArthur Foundation¹ which defines it as **“an economy designed to regenerate itself”** specifying that “in a circular economy the flows of materials are of two types: the biological ones, capable of being reintegrated in the biosphere, and the technical ones, destined to be revalorised without entering the biosphere”.

The **circular economy is an approach that farmers and breeders know very well** because, for example, one of the characteristics that regulates the proper functioning of a farm is the integration between the many activities: the straw that remains from the cultivation of cereals is often used for animals (as food or litter), while manure is a valuable aid in fertilising land. The meat and cured

meats sector certainly contributes to this circularity: many by-products generated during food production, both in the field and in the transformation processes, have animal feed as their main destiny. Entering even more in detail, we can see how **the breeding of cattle is one of the most articulated and circular** that exists since the so-called cow-calf supply chain produces meat, milk, skin and many of the by-products generated during the slaughter phase are destined for the most varied of uses.

In this last field, research and industrial innovation are certainly important in maximising the possibility of reuse. One of the most famous examples is that of the veal slaughterhouse which is used for the production of natural rennet, still considered the best from a qualitative point of view for the production of all PDO cheeses. These characteristics of integration and circularity must also be taken into consideration when calculating environmental impacts. The correct attribution of the impacts must in fact follow appropriate “allocation rules” that allow the relative environmental loads to be distributed to the various products.

In other words, taking 100 as the impact score of breeding a cow, how much should be attributed to the cow’s meat? How much to the calves generated throughout life? And to that of milk? And to the manure used as fertiliser? It is therefore clear that the analysis cannot be trivial-

ised by evaluating a single process, but trying as much as possible to analyse systems in their entirety. This is undertaken following common conventional rules decided after international public consultations as will be described later.

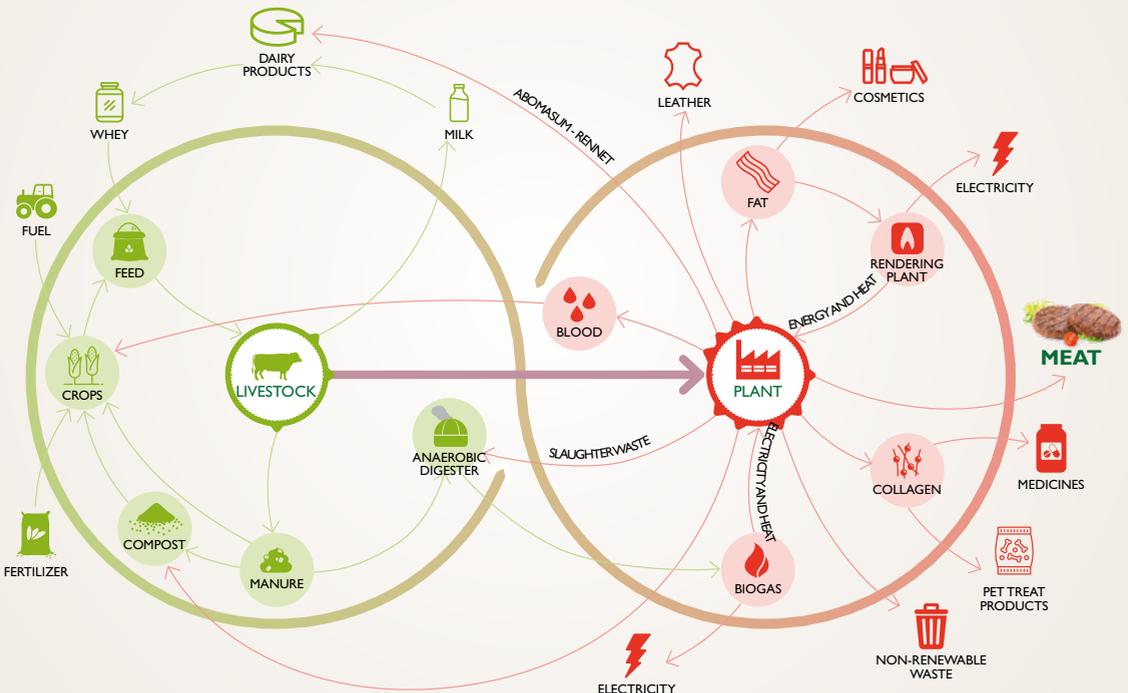
1.2 Reduce impacts looking for efficiency

The calculation of impacts can be finalised both for “informative” purposes and the desire to reduce the pressure of the supply chains for the environment. This

second aspect is normally the result of an efficiency research process known as the measure of the resources used to reach an objective. While from an economic point of view the question is quite intuitive (reduce costs equal to revenue), when you deal with the topic in the analysis of an agricultural supply chain, and even more from a livestock prospective, the matter does not start to become so immediate. There are two main aspects.

On the one hand, dealing with living beings opens the discussion to many aspects of an ethical nature (smaller spaces

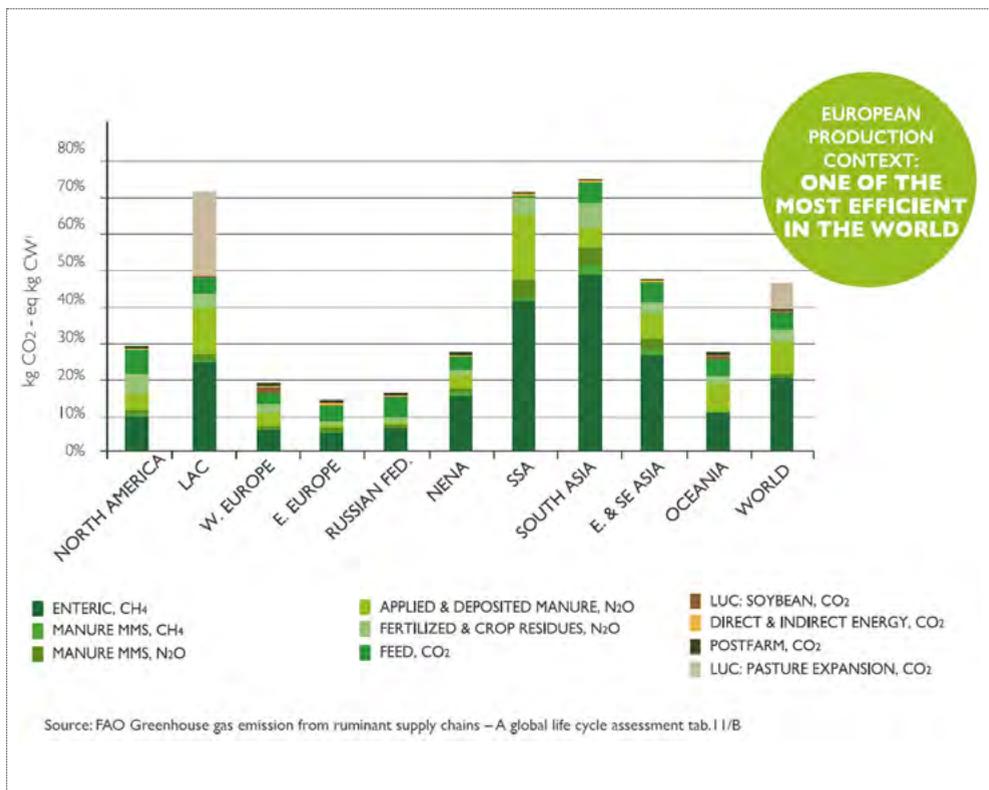
THE CIRCULARITY OF THE COW-CALF CHAIN



for animals results in lower environmental impacts). On the other hand, the fact that the profound integration of agri-food chains creates a balance of relationships and flows that must be taken into consideration every time a decision is taken: the fact of sending the manure generated by a cattle farm to bio-digestion also has consequences on farms that receive it (or should have received it). So the questions are many; one of the most frequent is whether a barn or pasture is better (more sustainable). Since there are good reasons in both cases, the answer must be sought after defining the values and tak-

ing different points of view into account: animal welfare, safety, quality and meat taste, environmental impacts.

In order to be able to talk about sustainability, therefore, we cannot take into account only environmental aspects, but an overall equilibrium in production. This is what many scholars have tried, and try, to do in many projects throughout the world.



Emissions of carbon dioxide in cattle breeding in the world.
Source: extract from INALCA Sustainability Report, 2016

MAIN USES OF SLAUGHTER BY-PRODUCTS



BONES

are used for producing pet food, animal fodder, fertilisers and gelatine used for food and pharmaceuticals



CATTLE AND PIG SKIN

are used for producing leather products: veal leather is used for luxury articles (shoes, handbags, belts etc.), steer leather is used in the automotive sector (car seats), cow leather is used for making sofas and leather goods while pig leather is used to line shoes internally



FAT

is used in the cosmetic and chemical industries (soaps) as well as in the livestock sector (to produce animal fodder)



PORK RIND AND CARTILAGE

are used for producing food thickening agents as well as pet food



PORK RIND AND OTHER SINUOUS PARTS

are used for producing gelatine, both for food preparation (mainly pork) and pharmaceuticals (mainly bovine) for preparing films required for encapsulating medicines



BLOOD AND ENTRAILS

pig entrails are used for producing cured meats, while bovine blood is used for producing fertilisers and animal proteins, while chicken blood is used for pet food



PERICARDIUM

taken from both bovine and pork, are used for making medical devices (heart valves)



FAT LIQUIDS AND RUMEN CONTENT

along with other wastes are used for producing green energy (biogas cogeneration)



ABOMASUM

(the last cavity of the four stomach chambers of ruminants) is used for making rennet (for example it is the only coagulant that can be used for making PDO cheeses such as Grana Padano or Parmigiano Reggiano)



PORK BRISTLES

once used for making paintbrushes and brushes, today they are mainly used for making flours for livestock use



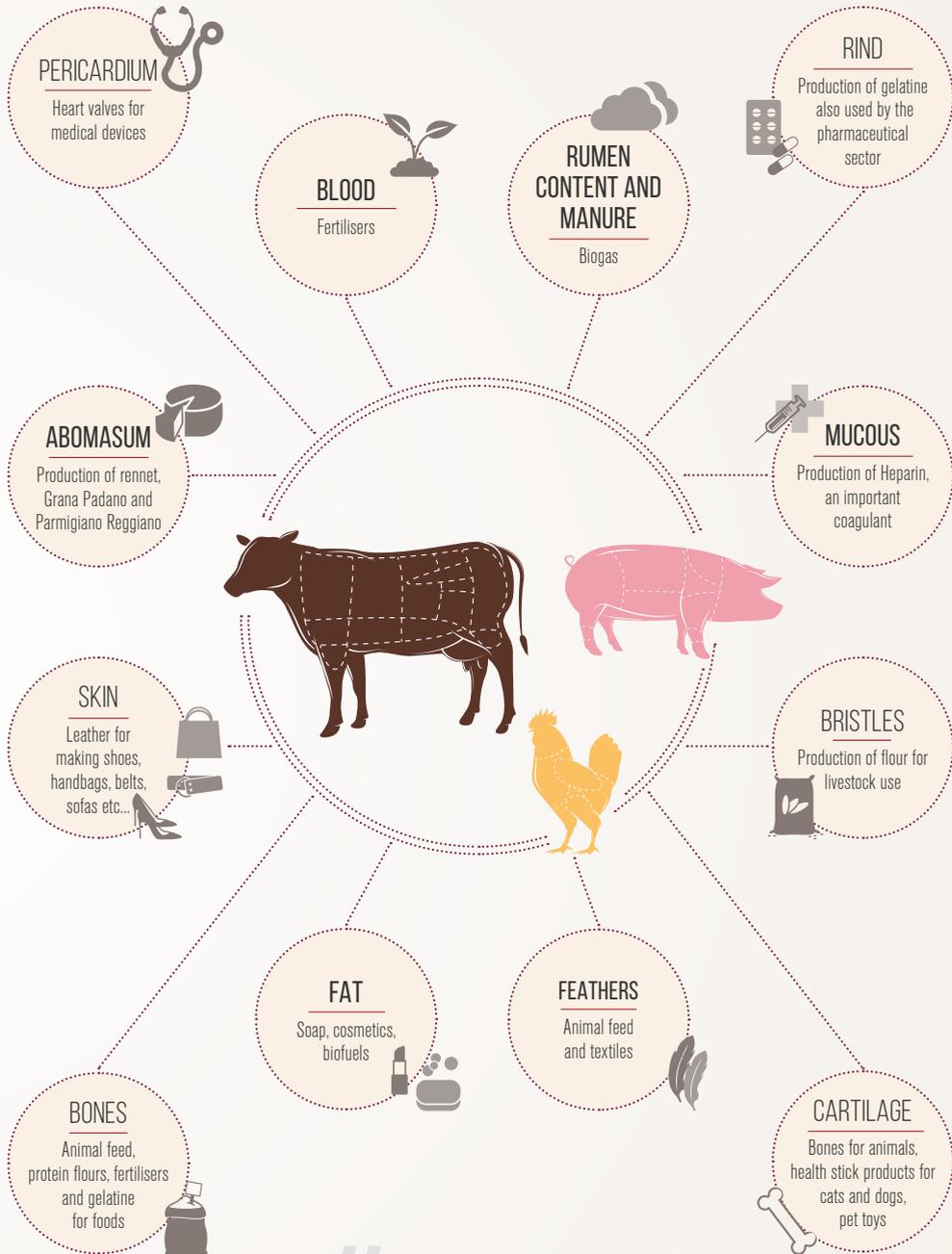
PORK MUCOUS

(extracted during the preparation of pork entrails) is used by pharmaceutical companies for making Heparin, which is an important coagulant medicine



THE FEATHERS

are used in the production of animal feed and in the textile industry



NOT ONLY MEAT IS OBTAINED FROM AN ANIMAL

LIFE+ PROJECT CLIMATE CHANGE-R

The LIFE+ Climate change-R was a LIFE project promoted and coordinated by the Emilia Romagna Region in 2013-2016, which focused on the theoretical and practical study of cultivation and breeding techniques that, with equal production yields and same product quality, allow the reduction of greenhouse gas emissions. The project was attended by some of the most important national and international agri-food groups and Italian large-scale retail traders.

The project was based on an integrated approach between the agricultural, industrial and distributive parts as well as the circularity induced by dialogue and exchange between the world of plant and animal productions.

The starting point was the approach of the integrated struggle, a long-established practice in Emilia-Romagna, to which research and application was added to develop new agricultural and livestock production disciplines that foresee the most advanced techniques identified internationally. Among the main results of these approaches are certainly the reduction of the use of fertilisers and

plant protection products, a more rational management of water resources, lighter land processing techniques, different ways of handling manure and new types of animal feed. An important point was experimentation in a sample of farms that allowed confirmation of the validity, or the settings corrections, of the protocols being defined.

Regarding livestock production chains, the results obtained with the application of the **Good Practices studied** in the project are to be evaluated in a positive way, **with percentages of carbon footprint reduction ranging from a few percentage points up to over 30%** compared to the average impact of the individual supply chains, which in particular has been calculated in 1.2 kg CO₂eq/kg milk for drinking milk, 1.3 kg CO₂eq/kg milk for milk destined for the production of Parmigiano Reggiano and 11.1 kg CO₂eq/kg of live weight for beef. The most effective interventions are those related to **improving the digestibility of the ration**, which is capable of reducing enteric emissions and methane emissions from effluents, to which is added



the introduction of renewable energy, such as biogas and photovoltaics.

The results of the project, which have been considered by the Region for the preparation and updating of agricultural and rural planning, are available at www.agricoltura.regione.emilia-romagna.it/climatechanger.

THE ROLE OF FAO IN THE BREEDING OF SUSTAINABLE CATTLE²

edited by Susanna Bramante³

Livestock breeding is essential for the sustenance of a large part of the world's population, especially in areas where people still live in poverty. The global demand for products of animal origin is increasing, especially in developing countries, thanks to the progressive urbanisation, the population growth and the increase in income of the population: it is estimated that the demand will grow by 70%, to feed a world population that will reach the threshold of 9.6 billion people by 2050.

In this context, global meat production is expected to increase more than double, from 229 million tons in 1999/2001 to 465 million tons in 2050, and that of milk from 580 to over 1,000 million tons. The increase in demand for these products represents a great opportunity for around 1 billion people who depend on livestock breeding, as a source of livelihood and income. The growing demand for animal products is satisfied above all thanks to the rapid expansion of modern "intensive" farming methods linked to traditional systems. This reality needs to be positioned in the context of limited natural resources, given that the livestock sector ex-

erts an important pressure on many ecosystems, on biodiversity, water and soil quality and the global environmental impact. Livestock breeding contributes to **greenhouse gas emissions less than 2% in developed countries and more than 30% in developing ones**, significantly affecting the problem of climate change. So, while on one hand the exploitation of resources is considered high, on the other **this sector provides food with high nutritional value with important and positive economic and social implications contributing to food security and reduction in poverty.**

The livestock sector is the world's largest user of agricultural land, through pasture and the use of food crops. The natural resources that support agriculture, such as water and land, are becoming increasingly scarce and become ever more threatened by pollution and climate change. In this context, the United Nations Food and Agriculture Organisation (FAO) supports the sustainable development of breeding livestock, with the aim of reducing its environmental impact and use of resources, while increasing production efficiency. This need

is increasingly recognised among producers, society and governments and concrete initiatives have been put in place to effectively improve the use of natural resources. In particular, two partnerships have been established, in which the FAO is actively involved, bringing together many stakeholders (governments, public and private sectors, producers, civil society, international community organisations, research and academic world, the donors who are committed to funding the various FAO projects).

The Global Agenda for Sustainable Breeding aims to catalyse the action of stakeholders, with the aim of:

1) Increasing production efficiency: in the dairy sector, for example, through the improvement of health and nutrition of animals, it is possible to increase production by reducing the resources used, protecting the environment and ensuring food security.

2) Revitalize the grasslands: in the extensive breeding system, for example, the correct management of pasture allows the increase in production, storage of carbon in

the soil and the protection of biodiversity and water quality. Resizing the number of animals bred and the use of fertilisers, it is possible to increase the quantity and quality of the forage.

3) Improve the management of manure: in the intensive farming system, for example, the appropriate manure management allows to reduce air and water pollution, thanks to the production of biogas and the use of the effluents as fertiliser. The energy and nutrients recovered can replace the fuel and synthetic fertilisers.

4) The Partnership on Environmental Assessment and Performance of the Farm (LEAP), founded in 2012, focuses on the **development of specific industry guide-**

lines, to quantify and monitor the environmental impact and performance of the livestock sector. The initiative is the result of a consultation process started in 2010, between the Animal Production and Health Department of FAO and a group of representatives from food and agriculture sectors. Thanks to a continuous dialogue between stakeholders (governments, private sector and civil society), focused on the identification of objectives and on the consensus to work together, it was possible to develop the project, with the aim of creating a collaboration between the different parties interested in the purposes of the comparative analysis, monitoring and improvement of the environmental performance of the entire livestock chain, taking into consideration the

positive social and economic consequences.

Thanks to the technical, analytical and research skills, through the exchange of data and information organised in specific databases, this collective action will allow a better understanding and management of the key factors that influence the performance of the livestock sector and its environmental impact.

FAO is committed to providing comprehensive and reliable assessments of environmental impacts for the livestock sector, the potential for decreases and the concomitant effects on food security and poverty reduction. This is essential for stimulating political dialogue and taking the right strategic direction to follow.

GLOBAL LIVESTOCK ENVIRONMENTAL ASSESSMENT MODEL: THE FAO PROJECT

Among the many activities of the FAO, the GLEAM (Global Livestock Environmental Assessment Model) project is certainly worthy of note, which aims to evaluate, through the analysis of the life cycle, the environmental

impacts of meat production worldwide and identify possible improvement actions. Indications for further in-depth information to the official documents are available on the project's website, where the relevant data and con-

clusions, especially in terms of greenhouse gas emissions, are reported.

The first data concerns the total emissions of the livestock sector, estimated at around 7,000 million tons per year (7 Gt), which correspond to

about 14% of the greenhouse gas emissions of all human activities. In this value also fall the emissions associated with the change in land use, which occurs as a result of the replacement of forests with pastures or fields for the cultivation of raw materials for animal feed. Going specifically to individual meat, the most impacting species remains the bovine (from meat and milk), due to the enteric emissions that account for about 6-7%. The most important areas in terms of emissions are South America and Southeast Asia, followed by Europe and North America.

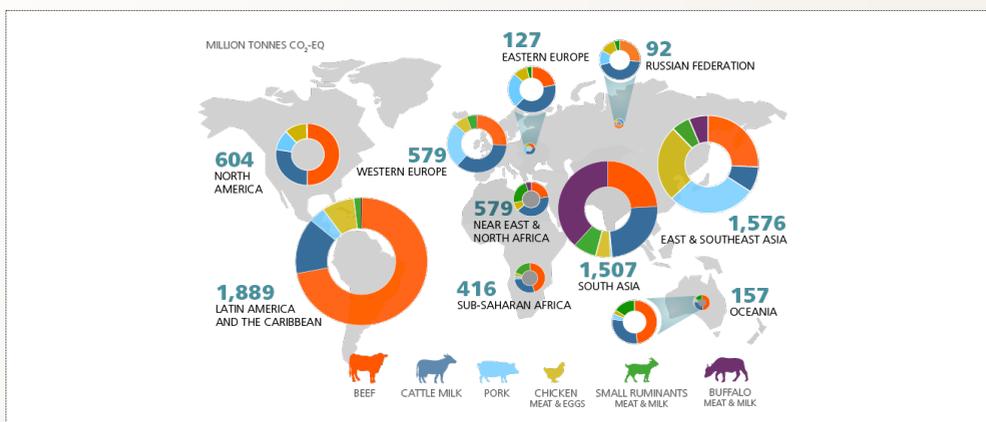
An important aspect concerns the differences in production between the various areas, both in terms of species raised and of breeding patterns: in South America

beef cattle breeding prevails, with systems mostly of an extensive type; in Asia, production is rather focused on dairy cattle and pigs; North America is a large producer of beef cattle in "industrial" systems, while production in Europe is semi-intensive, with a fairly balanced distribution among species, with a slight prevalence of pigs.

To these variations of production correspond obviously also differences of emissions. In the following figure it is possible to see how **in the countries where the extensive breeding prevails, the emissions per production unit are higher than in those regions where the system is more industrialised.** It should be remembered, however, that the excessive search for production efficiency can put product

safety to risk, or the respect for animal welfare.

A political-strategic type conclusion that can be reached is that the actions to improve the sustainability of the livestock sector must be calibrated on the peculiarities and needs of the regions to which it refers. For example, a reduction in per capita consumption would be desirable in regions where they are very high (for example North America); where instead the environmental impacts are very low and the consumption quite aligned to the nutritional suggestions, as for example in Europe, probably the most critical aspect could be that of animal welfare, upon which improvement interventions are certainly possible.



Greenhouse gas emissions by geographic areas

Source: www.fao.org/fileadmin/user_upload/gleadm/images/fig5.png

DEVELOPMENT POLICIES

THE SUSTAINABILITY OF THE AGRI-FOOD SECTOR

EUROPEAN CONTEXT



Development guidelines for the definition of the new Common Agricultural Policy (CAP) post 2020

Although there are no references to the sustainability assessment, Member States will have the burden of submitting annual reports on the achievement of defined objectives for the protection of the environment and climate (for example, reports on biodiversity, use of resources and soil quality).

On a voluntary basis: it will be possible to finance rural development plans or support schemes, incentives and the granting of subsidies to operators engaged in the use of agricultural practices considered “sustainable” according to the application of mandatory parameters to be defined. Minimum 30% of rural development funds will have to be spent for the definition of measures to protect the environment and the climate.

INTERNATIONAL CONTEST



Agenda 2030 United Nations

17 Sustainable Development Goals (SDGs) have been identified, articulated in 169 Targets to be achieved by 2030 in the environmental, economic, social and institutional sectors. The objectives regard, among others: environmental impact, employment and economic growth, workers' rights and communities. The EC is a promoter of Agenda 2030 (UN); on whose basis are defined the 10 priorities of the Commission in

matters such as: employment, energy and climate, trade policy. The SDGs were defined between 2000 and 2015 and constitute the development of the objectives initially defined within the “Millennium Development Goals” (MDGs). They certainly represent one of the most effective results of the inclusive and synthesising work carried out by the United Nations which has actively involved moreover 1,500 companies.

The SDGs are universally applicable in developed and developing countries and constitute the basis for operational plans, legislative actions and other policy initiatives. The SDGs have placed the economic activities of companies at the centre, as a necessary condition for their pursuing.

BUSINESS ACTIVITY IS A VITAL ELEMENT IN ACHIEVING THE OBJECTIVES OF SUSTAINABLE DEVELOPMENT. COMPANIES CAN CONTRIBUTE THROUGH THEIR ACTIVITIES AND WE ASK THEM EVERYWHERE TO VALIDATE THEIR IMPACTS, SET AMBITIOUS GOALS AND COMMUNICATE RESULTS CLEARLY.

Ban Ki-moon Secretary General of the United Nations



- 1 - **NO POVERTY** - End poverty in all its forms everywhere
- 2 - **ZERO HUNGER** - End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- 3 - **GOOD HEALTH AND WELL-BEING** - Ensure healthy lives and promote well-being for all at all ages
- 4 - **QUALITY EDUCATION** - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- 5 - **GENDER EQUALITY** - Achieve gender equality and empower all women and girls
- 6 - **CLEAN WATER AND SANITATION** - Ensure availability and sustainable management of water and sanitation for all
- 7 - **AFFORDABLE AND CLEAN ENERGY** - Ensure access to affordable, reliable, sustainable and modern energy for all
- 8 - **DECENT WORK AND ECONOMIC GROWTH** - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- 9 - **INDUSTRY, INNOVATION AND INFRASTRUCTURE** - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- 10 - **REDUCED INEQUALITIES** - Reduce inequality within and among countries
- 11 - **SUSTAINABLE CITIES AND COMMUNITIES** - Make cities and human settlements inclusive, safe, resilient and sustainable
- 12 - **RESPONSIBLE CONSUMPTION AND PRODUCTION** - Ensure sustainable consumption and production patterns
- 13 - **CLIMATE ACTION** - Take urgent action to combat climate change and its impacts
- 14 - **LIFE BELOW WATER** - Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- 15 - **LIFE ON LAND** - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- 16 - **PEACE, JUSTICE AND STRONG INSTITUTIONS** - Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- 17 - **PARTNERSHIPS FOR THE GOALS** - Strengthen the means of implementation and revitalize the global partnership for sustainable development

The 17 global sustainability challenges (SDGs). Source: <https://sustainabledevelopment.un.org/>

IMPACTS ALONG THE SUPPLY CHAIN

Like people have, animals have dieticians as well. They establish the appropriate rations for the various animal species during the various phases of their lives.

Soy, corn, sunflowers, alfalfa and hay are the main raw materials grown for making feed for livestock.

Breeding farms can be managed according to different production models according to both where they are located and the type of animals bred.



PRODUCTION OF FEED



use of fertilisers and agrochemicals



use of diesel fuel



land occupation



use of water

BREEDING FARMS



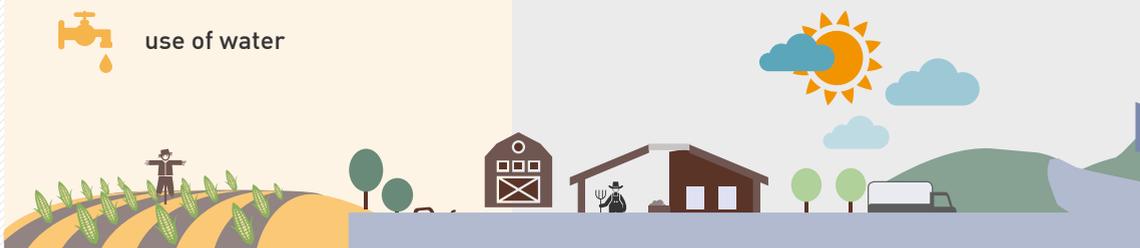
the management of animal excrement



energy consumption



use of water





Although it is often believed that the most significant phases are those related to industrial processing or distribution, **more than half the overall impact derives from farm management and feed cultivation.** Agricultural and livestock farms are therefore the places where it is necessary to work to control and reduce, where possible, the factors of environmental impact.

The transformation phase begins with the slaughtering of the animals and includes, when foreseen, the production of more elaborate products such as cured meats.

Distribution involves all of the production phases up until the retail stores or the meat's consumption.



TRANSFORMATION



energy consumption



waste production



use of water

DISTRIBUTION



transportation



energy for conservation



use of packaging



1.3 Feed production

The first phase of a livestock production chain coincides with that of feed production. The first step is therefore to understand how the feeds are composed, what are the main raw materials needed to produce them and how the impacts vary in the various supply chains. The relevant impacts of this phase are attributable to the agricultural phase: for poultry and pig meat, this item can constitute up to 60-80% of the emissions of the entire production system (farm to gate); in the case of beef, the agricultural contribution is a little lower, about 35-45%, because for ruminants, a large part of the emissions are linked to enteric fermentation⁴.

It is therefore clear that the challenge of sustainability in livestock production can only be won by involving in a systematic

and farsighted way all the players of the supply chain, including farms. The feed intended for farm animals is mainly composed of a mixture that includes cereals (corn, wheat, barley), legumes (such as soy), vitamins and trace elements according to a diet that is established on the basis of needs related to the type of breeding and to its productive specialisation.

In Italy there are farms that self-produce a large part of livestock feeds and **are part of integrated supply chains**. This practice, which is an indisputable strong point for breeding, is applied **above all in the case of ruminants** as they are capable of enhancing the biomasses of the pastures. This type of management allows the adaptation of agricultural production to specific nutritional strategies adopted by breeding, as well as a strong control capacity and good local application of agricultural practices, including the tech-

BREEDING FARM	BEEF	DAIRY COW	CHICKEN MEAT	PORK
TOTAL RATION	15-20 KG/DAY	25-30 KG/DAY	0,15 KG/DAY	1,35 KG/DAY
CORN OF VARIOUS TYPE	65-70%	60%	25-30%	45-50%
SUNFLOWER	8-10%	< 5%	-	-
SUGAR BEETS	5-10%	< 5%	-	-
WHEAT AND OTHER CEREALS	5-10%	10%	20%	30-35%
SOY	< 5%	< 5%	40%	15-20%
GRASS AND HAY	< 5%	20%	15%	-
SUPPLEMENTS	< 5%	< 5%	-	< 5%

Average rations (same quantity) of some species raised in barns in Italy

niques of “**Precision farming**”, which can substantially affect the overall sustainability of agricultural production.

In the case of pig and poultry livestock production, the correlation between self-production of raw materials and livestock production is less strict. In these cases, we develop integrated supply chains that include livestock and feed mills, able to specialise the feed production to the specific type of livestock production. With respect to the free marketing between producer and feed user, **the integrated supply chain allows a greater consistency in production quality and above all greater control capacity**, both in terms of food safety and sustainability aspects. In general, vegetable raw materials for feed processing are bought on domestic and foreign markets. Depending on the type of agricultural raw material, the **degree of national self-sufficiency production is variable**.

In the case of soy, for example, Italy cannot be self-sufficient and must necessarily import from the most suitable territories,

such as some areas of the South American continent. In such cases, the Community legislation provides for a complex system of rules concerning health safety and traceability throughout the food chain. It must be remembered that, from the point of view of safety, **feeds are equated with food for humans and are placed within the same rules provided in this sector**. Although in the context of international trade it is more complex to implement projects to improve sustainability, it is important to clarify that, even in the case of the globalised markets of agricultural commodities, voluntary circuits for the control and certification of sustainable production are available. An example in this sense is represented by the sustainable soy production and certification systems, the most important of which is represented by RTRS - Round Table on Responsible Soy (www.responsiblesoy.org).

With the aim of reducing the dependence on plant production from other continents, **the European Union promotes and**

BOVINE: THE HERBIVORES THAT TRANSFORM CELLULOSE INTO PROTEINS

work of conversion. In fact, ruminants have a real natural bio-fermentation system consisting of rumen and large intestine. These organs allow the transformation of the cellulose contained in the vegetables, that is the non-digestible fraction for humans. The digestion of cellulose in ruminants is carried out by a complex and partly still unknown microbial flora that develops in these bovine organs. It is only thanks to this system that the animal is able to **convert vegetable products (otherwise indigestible) into noble proteins, such as milk and meat**. In fact, the biological process of rumination determines the transition from the plant to the animal world. This is the reason why ruminants were the first animals since prehistoric times that have coexisted with the human species, guaranteeing the supply of high biological value proteins, starting from poor vegetables without bioavailability for humans.

The complexity of the metabolism of cattle and the specific characteristics of the emissions are the expression of a complex

supports the use of waste and by-products deriving from agri-food supply chains for livestock production according to the principles of the circular economy. On this theme, numerous research paths are in fact aimed at expanding the technologies and the portfolio of livestock food obtained from food waste, suitable for the production of feed.

The animal diet has in fact always been completed by **residues or by-products of the various phases of industrial processing of food products**, such as fruit and vegetables not usable for sale, by-products of grinding cereals, non-compliant pasta and bakery products, residues from milk, beer, tomato industries or even the used panels from the extraction of soybean oil, sunflower and colza, excellent

source of protein. The environmental advantage in the use of these materials is multiple: it reduces the dependence from abroad of feed materials, it saves agricultural land used for the **reduce waste by recovering resources that would otherwise be disposed of**; in addition, the use of former food products to be used as an ingredient for animal feeds, is in fact an efficient system to eliminate, or at least reduce, the waste of food resources⁹.

The crucial point is the relationship between the quantity of edible proteins for humans intended for animal feed and the amount of (edible) protein obtainable from the breeding of animals.

To increase efficiency and decrease, as far as possible, the use of edible proteins for humans as livestock food, it is impor-

GFLI, WORLD PROJECT TO MEASURE THE ENVIRONMENTAL IMPACT OF FEED

The purpose of the Global Feed LCA Institute (Gfli) is to measure the environmental impact of feed production. This is a project

launched in the United States in 2015 and promoted by various international associations such as Fefac (European federation of feed manufacturers), Ifif (International federation of feed manufacturers), Afia (American feed industry association) and the Anac (Animal Nutrition Association of Canada), in addition to a consortium of international companies.

The goal of the Gfli¹⁰ is:

- adopt a standard method for assessing and analysing impact on an international environmental scale related to the production of feed;
- guarantee the creation and use of a free and transparent database that collects all the information on the life cycle of ingredients used in food production for animals;
- create a method of comparative analysis of the effects that feed production has on the environment.

Gfli has also established a partnership with the FAO and the Livestock Environmental Assessment and Performance Partnership to ensure that its activities are compatible with the methodological requirements defined by the two organisations. The technical program of the Gfli has been designed to also comply with the Pef (Product environmental footprint) project, to detect the environmental footprint of products and coordinated by the European Commission.

tant that animal husbandry and feed are increasingly optimising the use of crop residues and by-products, trying new combinations that keep conversion efficiency and animal welfare equally high⁹. Since the world population continues

to grow along with the demand for food, **farm animals will play an essential role in the conversion of foods that are not edible by humans into quality proteins.**

FOOD	EXAMPLES	EDIBLE BY HUMANS?
CROPS FORAGE	Pasture grass, alfalfa, clovers, hay, silage.	No
CEREALS	Grain corn, wheat, barley, millet, sorghum, triticale, oat	Widely
VEGETABLE PROTEINS	Soy (paste and flour), cotton (seeds and flour), colza and peanut flour	Partially
CEREAL BY-PRODUCTS	Distillation industry cereals, corn gluten, wheat bran, straw, crop residues	Partially
VEGETAL BY-PRODUCTS	Apple peel, citrus pulp, almond shells, fruit/vegetable scraps.	Partially
EX FOOD PRODUCTS	Products not usable as food, packaged or not, deriving from both the production and distribution process	Partially
BY-PRODUCTS OF SUGAR FACTORIES	Molasses and beetroot pulp	Partially
ANIMAL BY-PRODUCTS	Waste meat and bones, tallow, feathers, blood and flour, usable as pet food.	Partially
DAIRY BY-PRODUCTS	Milk, whey, casein.	Partially
FISHING BY-PRODUCTS	Fish waste, fish oil, algae.	Partially
OTHER	Vitamins, minerals, probiotics, yeasts, enzymes, preservatives.	Partially

Examples of foods commonly used in animal production systems

CIRCULAR FEEDING: THE CASE OF EX-FOOD PRODUCTS

edited by Valentina Massa - Dalma Mangimi

Animal nutrition is a cornerstone for food security, animal welfare and sustainability. A fundamental link in the chain, which has improved over the years in terms of production efficiency, playing a key role in reducing environmental impacts thanks to the increasing use of **by-products, co-products and ex-food products**.

The starting point has always been tradition: the use of by-products among feed ingredients has always been intertwined with agricultural and food production. To this has been added an increasing technical-scientific competence in the management of "precision" formulations for each type of animal and in the specific breeding phase.

By-products are talked about a lot; a classic example is wheat bran, resulting from the decortication of wheat for flour production. An ingredient of which little is spoken, at least for now, and which is still an excellent example of circularity, is that of the former food products defined by the European Commission as those **"food products, other than the**

residues of catering, generated, in full compliance with Community legislation on food, which are no longer intended for human consumption for practical reasons, logistics or related to manufacturing defects, packaging or other, without presenting any risk to health if used as feed" (REG. UE 68/2013).

There can be various types of ex-food products, the most common are products derived from the process of transformation and selling of food (such as biscuits, pasta, snacks, bread, snacks, sweets), packaged or in bulk and, following appropriate processing as unwrapping and mixing, become excellent raw materials that replace cereals, sugars and fats in animal diets. It is not a question of waste but of feed materials that have passed from the status of "food" to that of animal feed. This procedure ensures maximum safety and traceability, thanks to the HACCP management plan.

Most of these former food products have already undergone a cooking process, which greatly improves the

digestibility of starches and increases the digestible energy of the ration. The inclusion in feed of ingredients based on ex-food products was strongly promoted by the European Commission for two reasons: on the one hand we could reduce "a food waste" unintentional and unpredictable, while on the other, enhancing the use of nutritive resources selected for feed (characterised by high quality lipids, more digestible starches due to cooking, important sources of sugar as well as a reduced risk of contamination from mycotoxins), the need is reduced to use traditional raw materials that require for their production soil, energy, water, fertilisers and sometimes even plant pesticides. For these reasons, the European Commission has published a series of provisions to reduce food waste⁵, as part of communications on the circular economy⁶. One of the initiatives consists in enhancing the nutrients of foods that, for commercial reasons or due to manufacturing problems or certain defects, are no longer destined for human consumption, through their safe use in animal feed. **This recovery does**

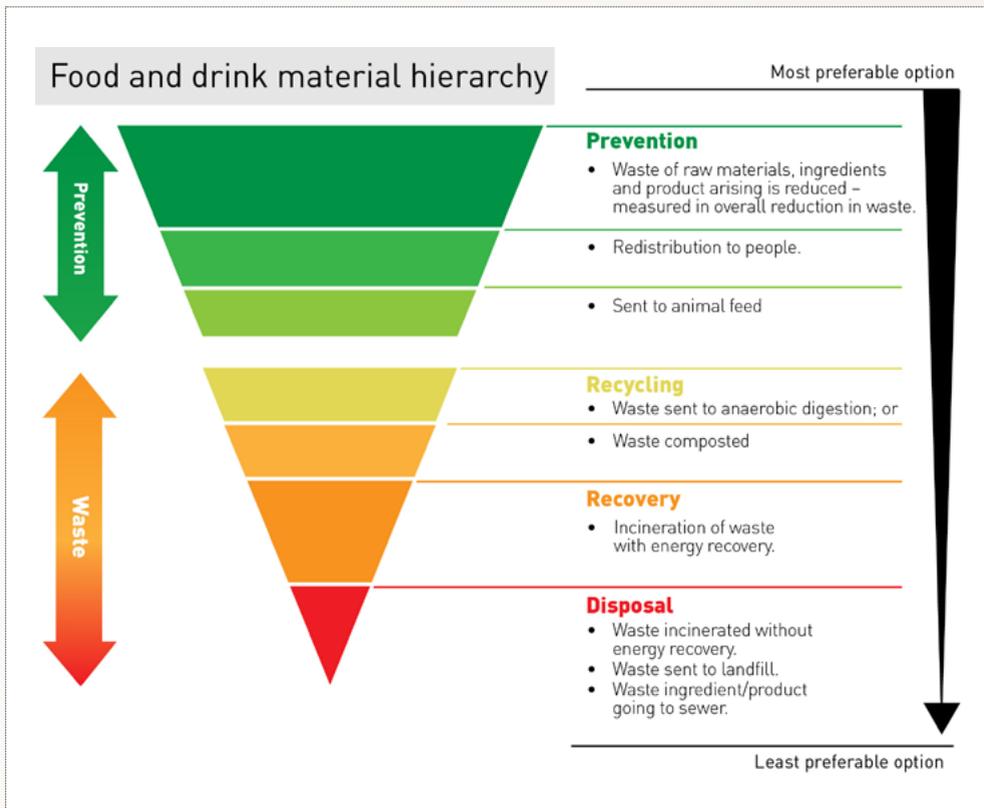
not in any way compete with the supply of food banks because it allows the recovery of surpluses in addition to those foodstuffs otherwise treated as waste and therefore composted, transformed into biogas, disposed of in landfill or incinerated.

The re-use of ex-product foodstuff as feed material is

finally to be preferred over energy reuse or landfill disposal, as also suggested by the hierarchies of reuse of waste food products⁷, promoted by EPA (US Environmental Protection Agency) and WRAP (the Waste and Resource Action Program) also endorsed by the EU Commission.

Today, therefore, it is possi-

ble to produce high quality meat with a reduced environmental impact thanks to a careful and attentive use of feed ingredients that are more sustainable and no less good or not safe, in line with the principles of the circular economy which provides safe recovery processes leaning towards a 0 level of waste.



Waste hierarchy for food products
Source: www.wrap.org.uk/content/why-take-action-legalpolicy-case

The impacts of agriculture

Use of fertilisers, irrigation and processing of land, use of crop protection products: in most cases the agricultural phase is the one in which the greatest impacts of the entire food production chain are found.

Fertilisers are substances that provide the soil with nitrogen, phosphorus and potassium, the nutrients necessary for the growth of plants: however, they are also **one of the first sources of environmental impacts in agricultural production**, both in terms of use and production processes, especially for those in synthesis. Amongst all, the greatest impact comes from nitrogen, due to the generation of protoxide that significantly affects the greenhouse effect. Moreover, when the fertiliser is supplied in excess, the residues not consumed by the plants can reach surface water courses, or the first underground water tables, causing an abnormal increase in the concentration

of nitrogen which favours an exaggerated growth of flora: the so-called eutrophication phenomenon.

Natural fertilisers, widely used in organic farming, can lead to a reduction in impacts, especially due to the lower load in the production phase, but once placed in the field the effects are the same: indeed, in some cases the use of natural fertilisers (for example manure) makes “evolved” cultivation techniques difficult, which aim at reducing impacts thanks to the use of innovative techniques and technologies. In addition to nutrients, plants need to be **protected from diseases**, insects and weeds. These have in fact a negative implication both for the health of the plant itself, and therefore on production yields, as well as for food safety in case the plant or its products are used in food production.

A defence can be made by administering to the plants (curative or preventive) the chemical substances (or natural, if avail-



able) during the various stages of growth, but also through an “intelligent” field management: for example, the fusarium infection, one of the diseases of wheat, more frequent when corn has previously been cultivated in the same soil. If the farmer takes this information into account when planning crop changes, he can reduce the use of chemicals and consequently reduce costs for the year.

Then there are operational choices, which require a decision in a very short time, based also on contingent situations: the weather, the risks of infection, etc. As they can have important environmental and economic impacts, these choices require ever more tools and information which the “traditional” farmer often does not have. For this reason, decision support systems (DSS, Decision Support Systems) that gather, organise, automatically interpret and integrate the information necessary to decide the most appropriate actions to respond to the most diverse cultural needs, be they long-term strategies or operational decisions to be taken quickly.

Abandonment and deforestation, two sides of the same coin

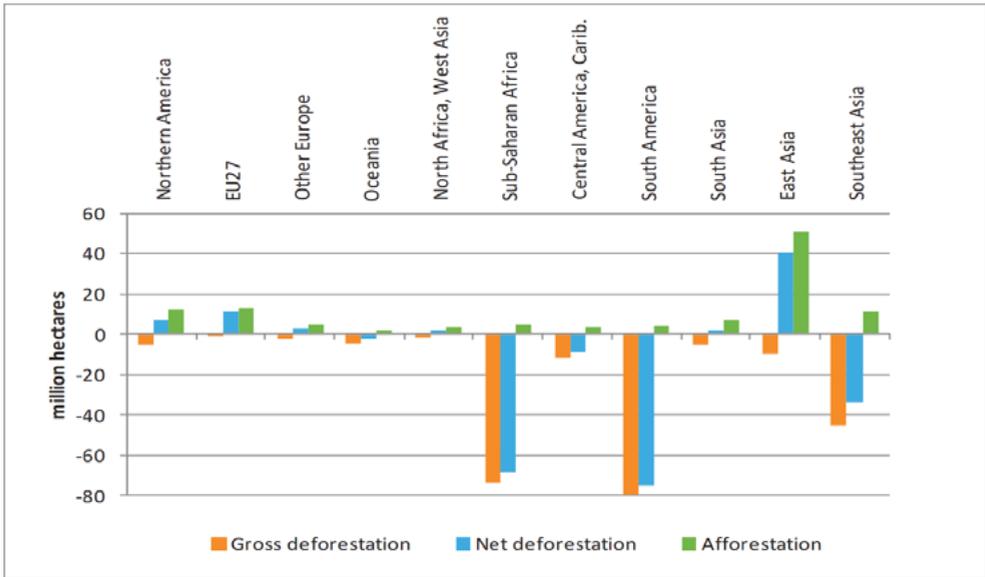
When we talk about territory, one of the most debated environmental aspects is the **use of the soil** that leads, paradoxically, to opposite problems depending on the regions of the world to which we refer: sometimes the main risk is the **abandonment** of the agricultural territories, in other cases the problem is the excessive aggression of anthropic activities to the natural environment (**deforestation**).

In Italy, for example, the main problem is represented by the conspicuous change from agricultural land to urbanised land, resulting in a general abandonment of territories by farmers. According to the

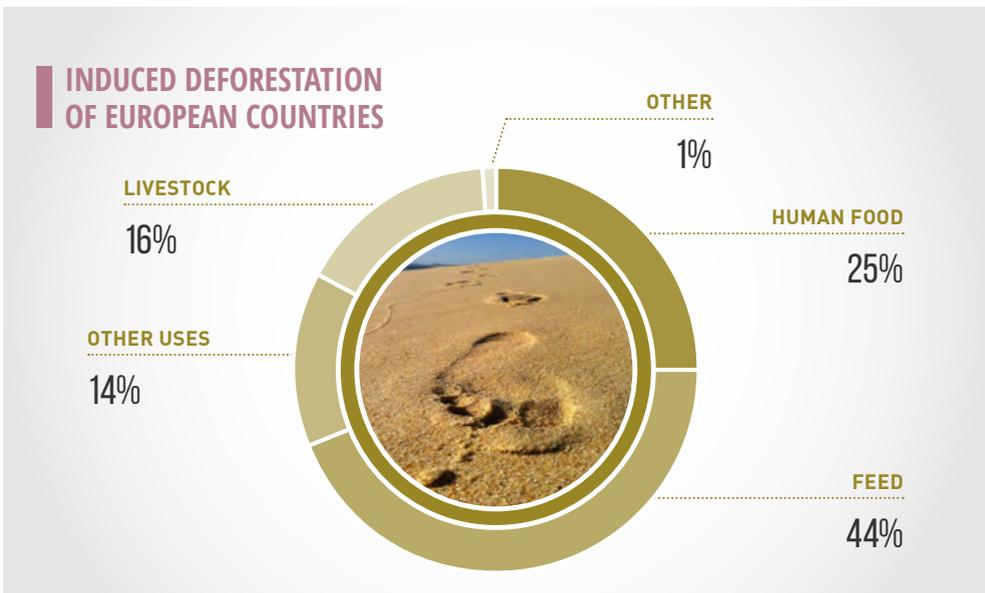
most recent data published by ISPRA¹¹, at national level, land consumption has risen from 2.7% estimated during the 50s, to 7.6% in 2016, equal to over 23,000 km². To this is added the incentive for renewable energy, which often pushed farmers **to convert land into “photovoltaic power plants”**, or to convert “food” crops to the production of resources used for energy purposes (the so-called bioenergy). This phenomenon involves various impacts, both economic and social, productivity is lost with the consequent need to purchase raw materials from abroad, and environmental.

The presence of farms is in fact extremely useful for the protection of the territory, because the continuous maintenance allows to reduce, for example, the risk of landslides and earth-falls, especially in those areas characterised by high hydrogeological risk.

The support, also economic, to agriculture and animal husbandry is therefore essential to avoid the progressive impoverishment of the “countryside”. In other countries, however, the problem concerns an agriculture that looks for territorial space to the detriment of other habitats. Just think of the uncontrolled **deforestation** of tropical forests in favour of plantations for the production of agricultural raw materials (mainly palm oil and/or soy) for food or energy, or pasture for cattle livestock. All these transitions, besides determining the loss (sometimes permanent and irreversible) of fertile soil, cause further negative impacts, such as the fragmentation of the territory, a reduction in biodiversity, an alteration of the hydrogeological cycle and microclimate modifications. Although Europe is not directly affected by the phenomenon of deforestation and indeed the wooded areas are expanding, there is an



Changes in the areas covered by forests between 1990 and 2008 in different areas of the world. Europe (EU27) is characterised by an expansion of forest areas (afforestation), but indirectly contributes to the phenomenon of deforestation. Source: EC Study, Technical Report 2013-063.



Deforestation induced by European countries in the period 1990-2008. Source: EC Study, Technical Report 2013-063.

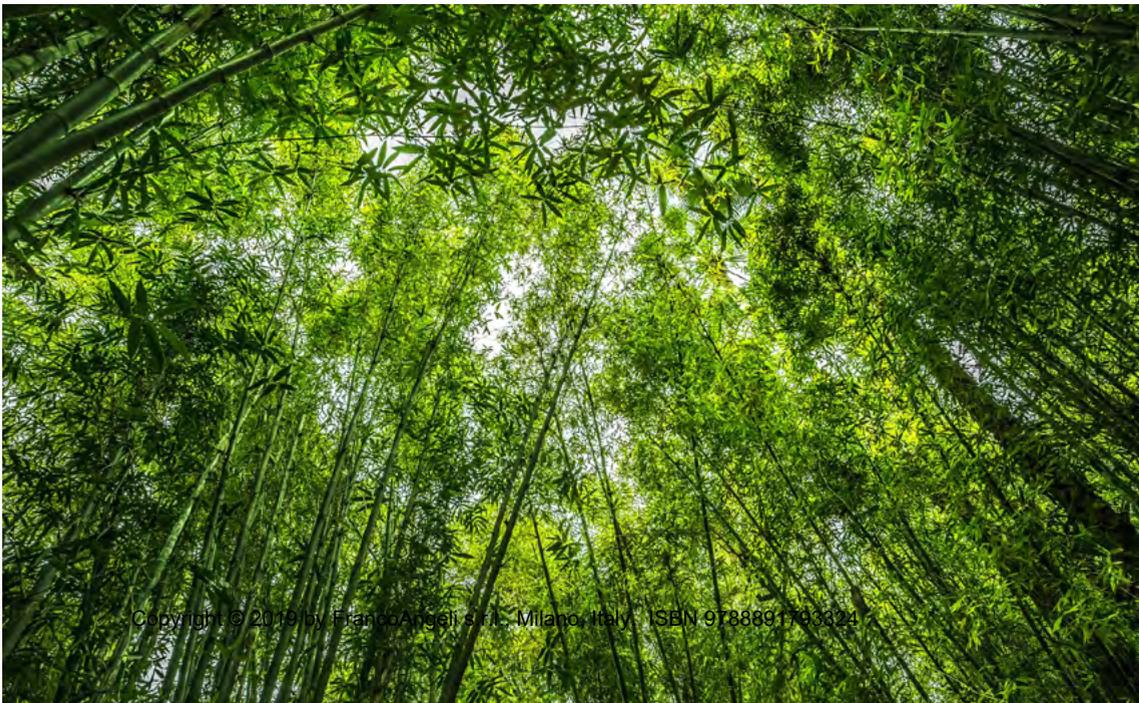
induced phenomenon (embodied) by the continuous and growing demand for raw materials. In all areas of the world there are phenomena of forest reduction and increase: those in which the net balance is strongly negative, however, are South America (33% of global gross deforestation), sub-Saharan Africa (31%) and Southeast Asia (19%).

In the period 1990-2008, **global gross deforestation** was estimated at **239 million hectares** (Mha). The **agricultural** sector has been responsible for the deforestation of about **128 Mha**: 49% is land destined for the production of feed, 8% is related to the cultivation of plant products for rations of pigs and poultry, 43% to the production of food of vegetable origin, bio-fuels and textile fibres. The top five crops that contributed to deforestation during the reporting period were soy (19%), maize (11%), palm oil (8%), rice (6%) and sugar cane (5%).

As for **Europe**, an **induced deforestation**

of approximately **8.7 Mha** (7% of the total) has been estimated, with the greatest contribution being the demand for animal feed, followed by that of raw materials for human food (soy and palm oil).

These data show a very articulated phenomenon, the management of which is extremely complex, and must necessarily take into account the world population's growing demand for food. The containment of meat consumption can be a solution only where these are very high; a global vision must however also aim at the efficiency of production. As seen for the emissions of greenhouse gases, for example, it is clear that pasture is not always the most sustainable solution, as regards also deforestation. One of the intervention aspects is represented by the adoption of specific policies for the acquisition of raw materials by the producers, in order to allow a control of the supply chain and complete raw material traceability.



GMO YES, OR NO?

One of the most controversial and recurrent aspects is certainly the one on GMOs (Genetically Modified Organism). These often end up in the dock accused of representing a danger to human health and the environment and, even more so, representing the very symbol of a highly mechanised agri-food model focused on monocultures. Although there are many works and many points of view on the topic, not always scientifically reliable, that of GMOs remains a sensitive issue that does not fail to trigger diatribes between supporters and detractors of this form of innovation. Below we tried to summarise the fundamental points of the debate, starting from the very definition of GMO.

The term “genetically modified organism” refers to any “organism whose genetic material has been modified differently from what occurs in nature with natural genetic coupling and/or recombination”.¹² In truth, the improvement or modification of the genetic characteristics of an animal or of a plant species has always been known. For this reason, it is good to clarify that the GMO techniques “un-

der trial” are those developed in the last 40 years¹³ and that allow the modification “in the laboratory” of some characteristics of the living species: for example, it is possible to increase the resistance of a plant to pesticides or certain pests, improve its nutritional profile or the ability to adapt to adverse climatic conditions (for example increasing its resistance in case of drought). The WHO (World Health Organization) **has long said that GMOs currently on the market do not pose a risk to human health.**¹⁴ Nevertheless, their use in the agri-food sector is opposed by a considerable part of the public opinion, above all because in the face of possible risks people do not perceive any direct advantage from the introduction of this new technology.

To help the average consumer juggle with scientific evidence, clichés, ideologies, the FAO provides a comprehensible synthesis of the potentially positive and negative effects of GMO cultivations, with a brief analysis of their verifiability.¹⁵ In Italy other interesting contributions to the debate on the subject come from the work of the Barilla

Foundation Centre for Food & Nutrition which since 2010 has published a series of reports aimed at deepening the issue of biotechnology, trying to identify which points are the most contrasting on the topic of genetically modified organisms¹⁶.

Among the relevant topics there are certainly environmental and ethical ones. As for the environment, among the aspects that attract the most attention is that of crop simplification, to which is inevitably binded the risk of a possible reduction in biodiversity. This concern is also exacerbated by the lack of knowledge of how these species can be invasive compared to traditional ones, which could lead to the disturbance of ecosystems in the areas surrounding those in which they are introduced.

On the other hand, from an ethical point of view, the problem of the patentability of GMO seeds arises, and therefore of the possible economic repercussions that the development of an oligopolistic market in the hands of a few companies could have on small farmers.

But where and why are GMOs used? The varieties of GMO

plants on the market today have been created to achieve resistance to parasitic insects (*Bacillus thuringiensis*, BT), tolerance to herbicides (Herbicide tolerant, HT) and resistance to viruses. Recently in Europe the cultivation of an Amflora potato (EH 92-527-1) has been authorised, with a high amylose content for the paper industry,

with the aim of increasing the productivity level of the supply chain in question. In the near future, the main reason for commercialisation will still be linked mainly to resistance to pests and herbicides, even if, for a while now, the need has emerged for complete plant varieties capable of adapting to adverse environmental and climatic

conditions: studies have been started to develop plants that can adapt to drought or significant temperature variations, or that can grow in soils that are rich in some minerals or metals. The main GMO crops in the world are **soy, corn and cotton.**



1.4 Breeding of animals

Breeding farms are the place where most of the environmental impacts of the meat and cured meats production process are generated; the most relevant aspects concern **enteric fermentations and the management of manure**.

These statements are supported, at least as far as greenhouse gases are concerned, by the data published by ISPRA¹⁷ which also shows a **reduction** of about **16%** of the total value compared to 1990.

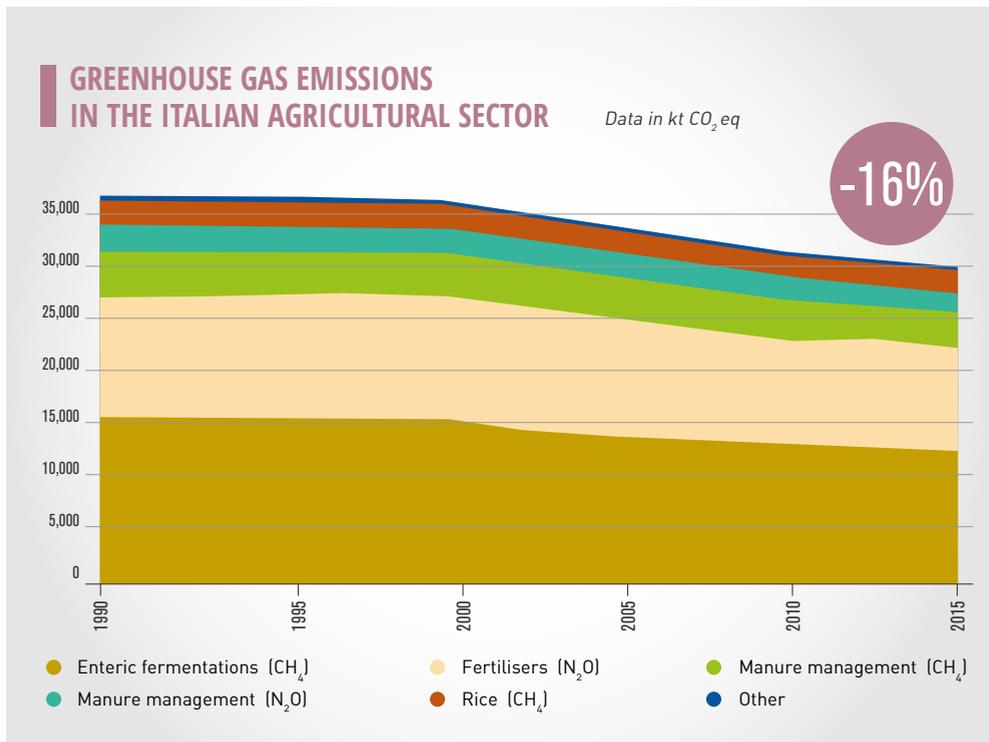
The enteric fermentations

Enteric fermentation is one of the results of the process of food digestion; it becomes particularly relevant in the case of ruminant herbivorous animals (cattle,

sheep, buffaloes, etc.), as it involves the production of a large amount of methane (CH_4). This gas has an effect on climate change 28 times higher than that of carbon dioxide (CO_2). The amount of methane produced depends mainly on the characteristics of the animal (race, age, weight), but also on the type and quantity of the food supplied. Some studies (Lauder A. R. et al., 2013) argue that **the relative impact of methane on climate change is overestimated, due to its short duration in the atmosphere compared to CO_2** .

How they are calculated

The IPCC organization has dealt with the calculation of enteric emissions in the guidelines published in 2006¹⁸, defining 3 approaches to estimate them with a dif-



ferent level of detail and insight.

The **Tier 1** methodology is the least accurate, but the simplest, as it provides the estimation of emissions only on the basis of the type of animal (for example beef or milk cattle) and the geographical area of origin.

The **Tier 2** methodology provides a more complex approach to calculation and a deeper knowledge of the farm in question; it should be used when the contribution is relevant, as in the case of cattle.

Finally, the **Tier 3** methodology is the most precise, but requires an even more in-depth knowledge of the farm examined.

For its application it is in fact necessary to have different primary information, such as the composition of the ration, the seasonal variation in the animal population, the quality and quantity of foods administered and the possible strategies to mitigate the impacts generated. Often this is information derived from direct experimental measures.

How emissions vary: an example of calculation

Tier 2 is the most used approach and an analysis of the formula leads to understanding how **emissions can vary** significantly with the diet of animals, both for the quantity and for the type of food. The calculation is based on specific emission factors that are a function of the diet administered according to the following formula, where:

$$EF = \left[\frac{GE * \left(\frac{Y_m}{100} \right)}{55.65} \right] * d$$

- **EF** (emission factor) = emission factor expressed in kilograms of CH₄ per head per year;

- **GE** (gross energy intake) = total caloric intake per head per year. It depends on the type of food and the quantity;
- **Y_m** (methane conversion factor) = energy conversion factor contained in food in methane. It depends on the type of breeding;
- The factor **55.65** (MJ/kg CH₄) is the energy content of methane;
- **d** is the number of days of administration of the reference ration.

Regarding the Y_m factor, its value depends mainly on the type of breeding: in bovine, the IPCC values are 3% for barn animals and 6.5% for pasture animals (or for cow's milk). With the same energy (constant GE), **the methane emissions generated by a pasture animal are twice that of an animal in the barn**. This statement cannot lead to a direct conclusion because, as mentioned, the total quantity of food administered must also be considered. Again with the logic of illustrating the calculation method, an example is presented in which the diets of a cattle at pasture and one reared according to the Italian production system are compared, then with a period of pasture and one in the barn. The comparison is to be considered preliminary, because in truth the assumptions and implications would be many: the first limit, for example, is to consider rations constant throughout the life of the animal, which in reality is not true.

The assumptions made can be considered reasonable for the purposes of this document, that of elaborating on the calculation and showing, among other things, why barn breeding generates a total of less emissions than at pasture.

ENTERIC FERMENTATIONS CALCULATION EXAMPLE



BOVINE AT PASTURE

- diet with 25 kg of grass per day;
- breeding time to reach the weight of 650 kg: 25 months.



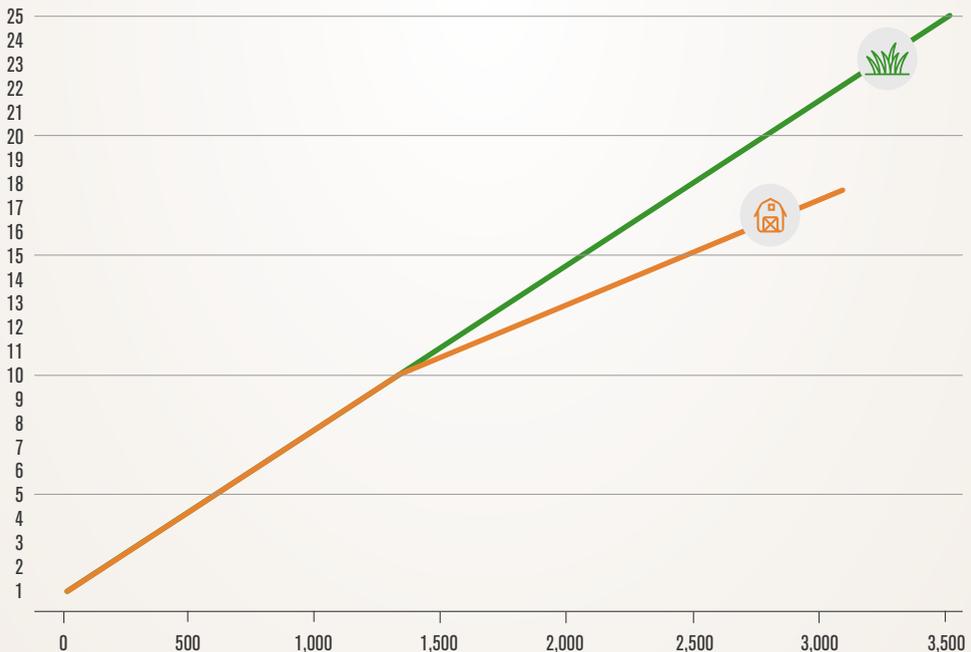
BOVINE IN THE BARN

- breeding times: 10 months' pasture; 8 in the barn;
- diet in the pasture period: 25 kg of grass a day;

• diet during the period in barns: 16.5 kg of food consisting of silage and corn pasty (60%); straw and hay (21%); beet (6%); soy (5%); sunflower (4%); wheat (4%).

The presented value includes both the enteric and the agricultural production of the raw materials used during the barn period. The diet in the barn is overall more impactful because despite being

characterised by lower enteric emissions, it must keep account of the cultivation of food. From an overall point of view, however, the impact is less because of the less time needed to reach the weight suitable for slaughter.



Total greenhouse gas emissions - kg CO₂ eq

The management of manure

The impact in the management of animal waste is due both to the **air emissions** of the volatile substances present (ammonia, methane and nitrous oxide) and to the release of **nitrogen in the soil**. In livestock farms these environmental aspects are related to two different times in the whole management flow: the **collection and storage** phase and the **final disposal** phase. When in the presence of outdoor farms, however, collecting the manure is impossible and the impact depends on its spreading around the fields and its control is almost impossible.

Collection and storage of manure on barn breeding farms

A first aspect to consider is the management of the breeding farm, that in the case of litter with straw or other absorbent material can give rise to **manure** (bovine) or **pollen** (poultry), or **slurry** (bovine or pig), in the case of breeding organised on slatted floor. Being almost solid materials, manure and pollen are more easily manageable than sewage. They are therefore to be preferred, because they make more alternatives possible for the subsequent storage and disposal phases.

In addition to this, it is to be borne in mind that they are generated by farms that provide for litter, and are therefore also better for animal welfare. After collection, the manure is stored to make sure that its treatment occurs in the most suitable time, way and place. Typical storage systems are many, but they can be characterised by a fundamental aspect that is coverage: especially in the case of sewage you can indeed find **open** or **closed** tanks, with very different effects from an environmental point of view. The open structures, of course, involve

greater emissions, both for the direct release of volatile substances, and for the occurrence of spontaneous fermentation phenomena that entail an additional dispersion of methane, CO₂ and other substances.

As for enteric fermentations, the **emissions generated** during storage can be estimated using the indications contained in the IPCC¹⁹ guidelines for the three main substances: **methane, nitrous oxide and ammonia**. Also in this case three approaches are possible, whose extremes are the tabular and the experimental ones; the intermediate scenario, Tier 2, is the one used for environmental impact calculations because it allows sufficient accuracy starting from normally known data.

Also in this case some elaborations can be presented, which allow to understand the differences in impact between the various possible storage methods. Unlike enteric emissions, however, formulas are more complex; for details refer to the IPCC documents. Emissions obviously depend on the amount of manure, from typology, but above all from storage modalities as technology and geographic area: the climate, for example, can be extremely influential in the biological degradation processes responsible for emissions.

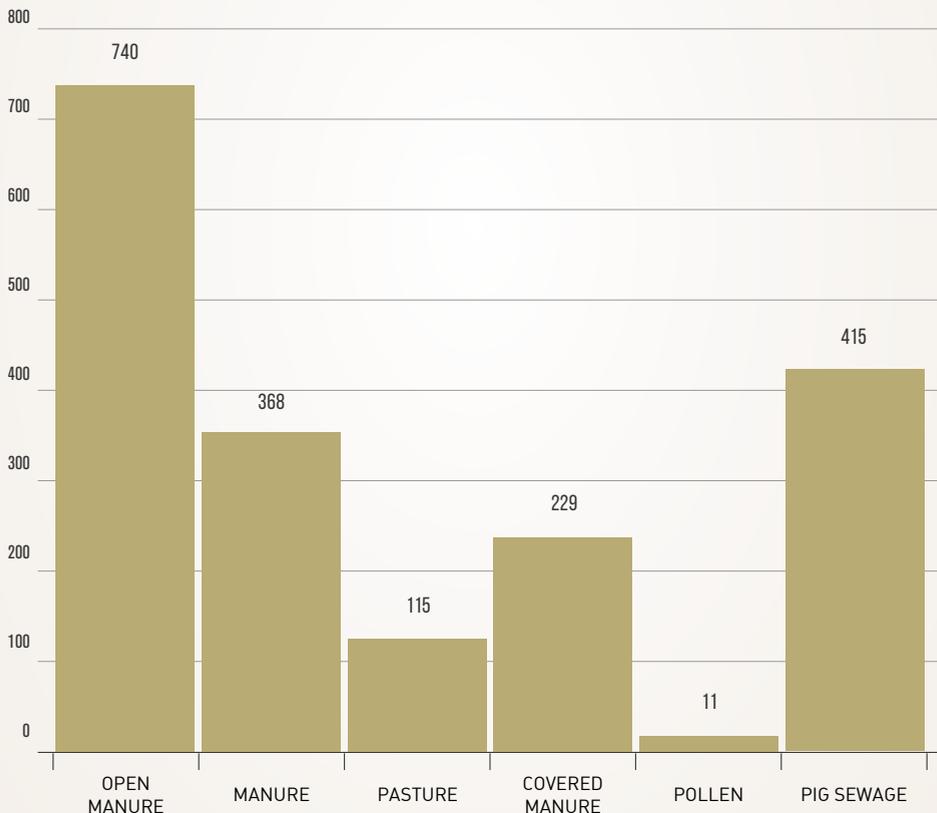
To improve its sustainability, the livestock sector should then direct investments towards a more rational waste management, **preferring, where possible, the production of solid material and therefore farms on litter**. In the case of beef cattle, this evolution is quite tangible, as shown by the data of COOP Italia published on the environmental product declaration which shows how almost half of the produced manure is managed in litter with manure production.

THE IMPACTS OF DIFFERENT TYPES OF MANURE STORAGE

To provide a preliminary estimate of the emissions associated with the main technologies of manure storage, a calculation was made keeping all the characteristics constant (climate, type of ma-

nure, quantity) and only modifying the storage technology used. Annual emissions of CH_4 and N_2O per head related to sewage management both in the case of cattle and poultry were estimated using

the data and methodology reported in the IPCC Guidelines²⁰. Regarding emissions related to the handling of pig manure reference was made to the study by Fabbri et al.²¹



Greenhouse gas emissions - Impact per head (kg CO₂e/head/year)

The spreading of manure in agriculture

After storage, manure must be disposed of. The possibilities are different and the choice depends on both the animal species from which they derive (they may have a different substance content) and the storage methods used.

In principle, their **spreading** in agriculture can be seen as a “closure of the cycle”, because nutrients (mainly nitrogen and phosphorus) can be returned to crops without resorting to chemical fertilisers. In this case, however, a correct management is fundamental, since an excess of use can result in uncontrolled releases of polluting substances, first of all nitrogen. For this evaluation, besides the quantity, it is also important to consider the quality

of the material used, because the organoleptic characteristics can vary greatly. In the case of pollen, for example, the low moisture content (30% compared to 90% of that of bovine or pig manure) makes it very concentrated in nitrogen and therefore its spreading must be done with extreme caution.

To limit impacts, the agronomic use of livestock effluents is governed by specific action programs (first of all the **Nitrates Directive**) that vary from region to region, so as to protect vulnerable areas from nitrates of agricultural origin. The fundamental principle is to have **available an amount of land proportional to the animals bred**, in order to be able to manage the manure directly on the farm.

MANAGEMENT OF BEEF CATTLE MANURE IN THE SUPPLY CHAIN

SEWAGE - UNCOVERED TANK

20%

SEWAGE - COVERED TANK

33%



MANURE

47%

Percentage breakdown of the methods used to manage the manure produced by beef cattle on farms that produce head destined for the COOP²² chain. This figure is representative of about 125,000 animals, equal to about 2% of cattle raised in our country (5.7 million cattle reared in 2014, with a decrease of about 8% compared to 2005, ISTAT-SIEV²³ data).

Intensive farms need to resort to the availability of agricultural land to transport the manure to areas with lower livestock density. The transport of manure is rather complex, but technological innovation has allowed us to develop various processes to make it economically sustainable, such as, for example, the drying of digestates, using the heat obtained from the combustion of the biogas produced by anaerobic digestion.

The treatment of manure: from problem to resource

The treatment systems of manure are generally aimed at the concentration of nutrients (nitrogen and phosphorus), so as to make it easy to transport as well as its use by farmers, in the case of products such as soil improvers or dung. One of the best known processes is composting which, by means of a controlled process of aerobic degradation, makes it possible to transform the material (usually manure or pollen) into soil improver. The process is done by mixing different types of organ-

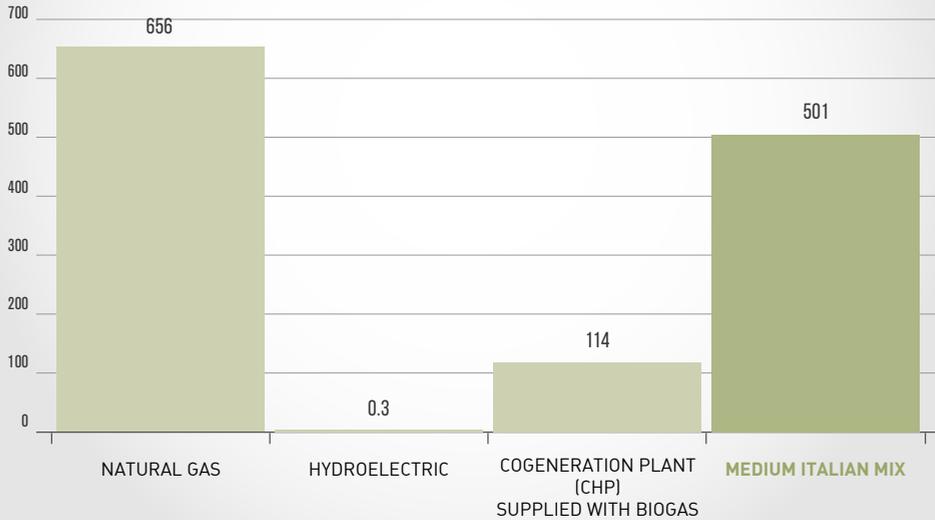
ic material, to provide micro-organisms engaged in the biological process with a constant substrate: the manure can therefore be mixed with sewage sludge, cuttings and organic waste deriving from separate collections. It is also interesting the case of the pollen which, when dried, can become an excellent fertiliser used also in organic productions. Among all the processes, however, one of the most noteworthy **is that of anaerobic digestion which, in addition to the treatment of manure, also allows energy production from non-fossil sources.** In fact, the process generates biogas, a mixture of CH_4 and CO_2 originating from anaerobic degradation processes of mixtures of organic compounds (manure, plant remains, whey, etc.). In this case the biological process is rather delicate: the treated material must be sufficiently balanced between dry materials (manure, food waste, vegetable residues) and wet (sewage, whey, blood, etc.), and a very well organised management of the plants is necessary.

	DAIRY COWS	BEEF CATTLE	POULTRY MEAT	PORK
Total Solids (ST) [kg]	12	8.5	22	11
Volatile Solids (SV) [kg]	10	7.2	17	8.5
TKN²⁴ [kg]	0.45	0.34	1.1	0.52
NH₃N [kg]	0.079	0.086	NP	0.29
P [kg]	0.094	0.092	0.3	0.18

*Main characteristics of different types of manure - data referred to 1000 kg p.c.²⁵
[Handbook of Agriculture, 1997 - chapter 6.7 "Management of animal waste" p. E-343 - HOEPLI ed.]*

BIOGAS: A RENEWABLE SOURCE

When the farms are structured and of adequate size, the necessary investments for the construction of a biogas production plant are sustainable. The environmental advantage in energy conversion, if compared to traditional energy production, is relevant. The operations chosen for the comparison derive from the Ecoinvent²⁶ database.



Comparison of 1 kWh of electricity produced with different systems - g CO₂/kWh



THE NITRATE DIRECTIVES

The Nitrates Directive (91/676/EEC²⁷) promotes the rationalisation of the use of nitrogen compounds in agriculture and provides that distributed fertilisers do not exceed the needs of crops, both for synthetic fertilisers which, in the case of organic matrices use, and for livestock manure.

Member States are obliged to:

- identify the Nitrate Vulnerable Zones (NVZ) of agro-livestock origin, areas characterised by already contaminated waters or that could become such in the absence of adequate interventions. These meas-

ures must ensure that, for each agro-livestock farm, the average quantity of livestock manure distributed on the land, including that deposited by the animals themselves, does not exceed each year a contribution of 170 kg of nitrogen per hectare. The limit for non-vulnerable areas is 340 kg of nitrogen per hectare;

- define and apply specific Action Programs in the NVZ that regulate the agronomic use of livestock effluents and the use of mineral and organic fertilisers containing nitrogen.

Member States may submit a request for derogation to the European Commission in the NVZ up to a maximum limit of 170 kg/ha/year of nitrogen from livestock effluents. This request must be supported by detailed agro-livestock and environmental information derived from previous and current monitoring data, which demonstrate how the increase in nitrogen quantities (generally up to 250 kg/ha/year) do not compromise the quality of the underground and superficial water.



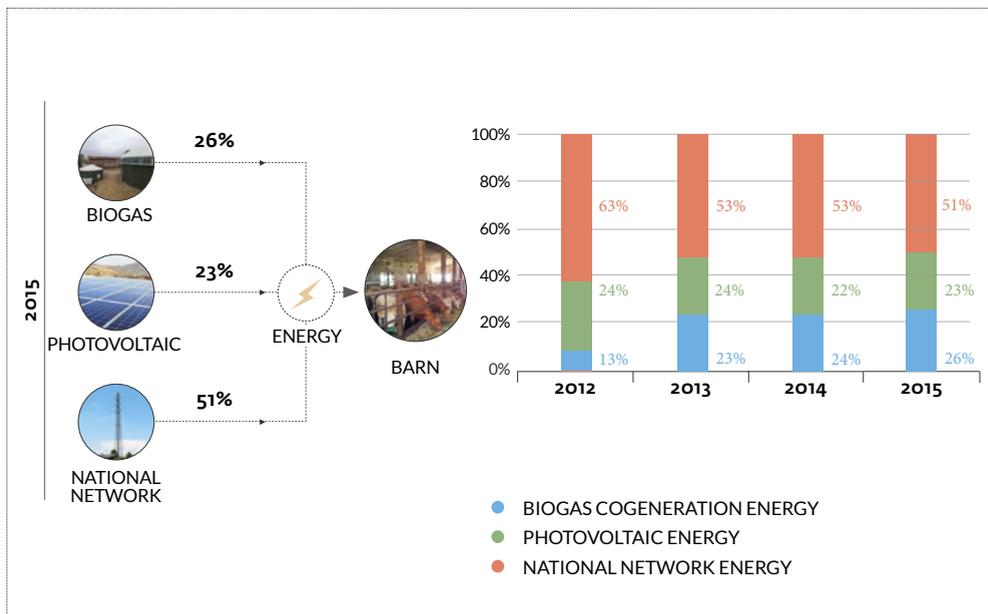
Energy consumption on farms

Energy consumption in livestock farms is due to the use of electricity for machinery and thermal energy to heat barns, food and water for washing. To reduce the impacts related to energy use, beyond the obvious practices of consumption containment, it is possible to use renewable energy production. In addition to the case of the biogas already mentioned, the large availability of space (think of the roofs of the breeding farm) permits the creation of interest for solar energy.

The improvement of the efficiency of solar panels, as well as their duration and the low maintenance need of the systems, have made some applications in the livestock/agricultural sector very interesting (for example on the roof of shelters, barns and sheds).

The main applications of the production of energy from solar sources are the exploitation for thermal uses and that for the production of electricity. These systems, as well as the production of biogas through anaerobic digestion, allow the reduction of direct energy consumption related to the breeding stage (which are usually modest).

The use of these systems is quite widespread, thanks also to the interventions of economic support made over the years by the Italian government. By way of example, the case presented is shown in the EPD of the COOP branded beef, which highlights the “virtual” energy mix used in the barns of the reference supply chain.



Medium energy mix used in Italian barns for the environmental declaration of COOP branded adult bovine meat²⁸.

Water consumption in breeding farms

The water consumption on breeding farms is largely influenced by the use of water for washing: the **reduction of waste** passes through procedures that prevent the generation of dirt.

Another consumer item is the one linked to drinking troughs, whose volumes depend on many factors such as health status, microclimatic conditions, type of feed and drinking system. Also in this case the technology can limit consumption, allowing the minimisation of waste without affecting animal welfare.

1.5 Slaughter and transformation

The “industrial” phase in the meat supply chain **starts at slaughter and ends with the creation of products** that are placed on the market. As with all processes, the environmental aspects relate to the use of energy and water, as well as the generation of waste.

It should however be noted that in the whole life cycle of foodstuffs the processing part is the **least problematic** from an environmental point of view, both because the impacts are quantitatively smaller than in the other phases, and because they are concentrated in a few points with high technological concentration, which makes it possible to maximise efficiency: consumption reduction and better waste management are in fact first of all a prerogative to reduce costs.

Waste or by-products?

The transformation of meat involves the generation of a large quantity of products that, although **not intended for human consumption, are a secondary resource very useful for other processes**. The management of this waste is quite com-

plex, because it is necessary to distinguish between by-products, co-products and waste, in a context where legislation is rather attentive in avoiding practices that pose a risk to human health.

The by-products are in fact divided into 3 families²⁹:

- category 1 (parts of regularly slaughtered cattle such as skull, entrails or carcasses of sick animals, etc.), intended for incineration;
- category 2, which includes manure, stomach contents of ruminants or dead animals in general;
- category 3, which includes materials with characteristics that would also make them suitable for human consumption (e.g. fat or bone), but are intended for other uses (such as production of pet food).

Without prejudice to compliance with the legislation and focusing attention on by-products destined for a second use in other productive systems, the industry is trying to exploit as much as possible the research and innovation achieved in the scientific field to give **added value to the by-products of animal origin**, going well beyond the usual profitability. In fact, there are many possible uses: human or animal food, feed, pharmaceuticals, fertilisers and by-products to generate biodiesel³⁰.

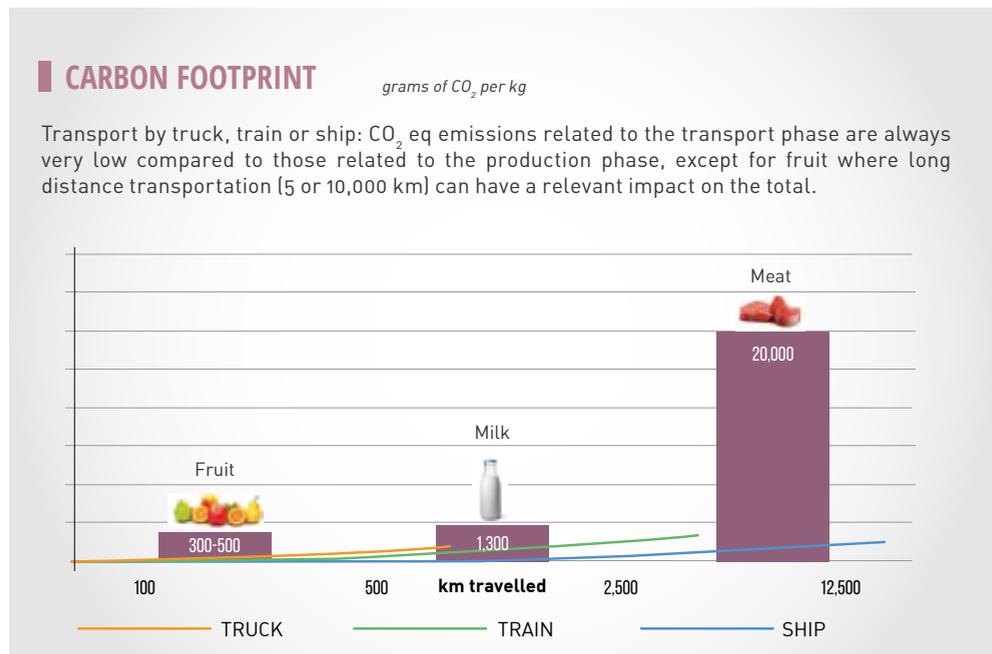
It should also be remembered that the organic material that cannot be recovered in other productions can be sent to **anaerobic digestion** for the production of biogas, and therefore of renewable energy, with the environmental and economic advantages already discussed previously in the part concerning the treatment of manure.

1.6 Distribution

The life cycle analysis approach allows processes to be examined with a complete logical system, sometimes leading to non-intuitive results and considerations. One of these are, for example, the 0 km products which are considered “sustainable” from an environmental point of view, intended as those which travel the least kilometres possible, from the place of production to the point of sale and consumption.

The basic idea would be to reduce the environmental impact that the transport of a product entails, for example by reducing carbon dioxide emissions. **It is not obvious, however, that consuming local products entails a reduction of the total CO₂ emissions of the food, as it is quite**

simple to show that transport has an almost irrelevant impact on the overall cycle. Comparing the impact on production and distribution of different agri-food products, it is clear that transport is relevant only for those characterised by a “simple” supply chain, such as fruit and vegetables. In the case of more complex products, such as meat or cheese, the environmental burden associated with distribution is almost as irrelevant, considering the impacts of the entire supply chain. For complex supply chains it is therefore much more important to focus on efficient processes with little impact, rather than on “neighbouring” products. The advantage of “0 km” comes from other points of view, such as the promotion of the regional agri-food heritage and the drive to rediscover territorial and cultural identity.



Source: Marino M., Pratesi C.A. “The Perfect Food”, 2015

CAN COWS CAUSE MORE CLIMATE CHANGE THAN CARS?

edited by Frédéric Leroy*

Can cows cause more climate change than cars? How can this be possible? When comparing direct emissions, the global output of livestock is much below the one of transportation.

In 2006, the FAO stated that livestock represents a larger issue than transportation with respect to climate change, leading to 18% versus 14% of the **greenhouse gas (GHG) emissions**. This news aroused incredulity and perplexity, and in fact, many objections were coming from experts in the field. A trenchant critique was given by prof. Frank Mitloehner (UC Davis, USA), protesting against the unfair use of LCA data for livestock but not for transportation, so that a direct comparison was not justified. This was a pertinent remark, acknowledged by a representative of the FAO in 2010. When comparing direct emissions instead (due to the lack of a common LCA framework), the calculated global output of livestock is even much below the one of transportation (5% versus 14%). Moreover, in its **"Tackling climate change through**

livestock" report from 2013, the FAO modified its LCA-based estimate of 18% for livestock to 14.5% based on an improved methodology using the GLEAM framework (corresponding with 7.1 out of 49 gigatons CO₂-eq/y).

In other words, the cows-are-worse-than-cars slogan was shown to be a fiction. Yet, anti-meat militants are not very eager to update their credo and keep on parroting the same line over and over again. Within livestock's overall 14.5% contribution, most of the blame goes to cattle. Beef and milk are said to be responsible for 41% and 20% of the emissions, respectively. Enteric methane fermentation and animal feed have been identified as the largest causes, whereas the rest has been ascribed to other factors such as manure decay. Enteric fermentation by ruminants indeed generates substantial amounts of methane (which is mostly belched by the cows, so it is not even about the "farts" in the first place). The latter correspond to some 29% of the total anthropogenic methane emissions worldwide. Methane receives a lot of attention because it is

known to be a more potent GHG than carbon dioxide (28x), but not so potent as nitrous oxide (265x). Because of its potency, methane is said to be responsible for about 16% of the total GHG emissions, when expressed as CO₂-eq. However, whereas methane emissions increased massively during the post-industrial era, they are now levelling off, in contrast to the ever-increasing CO₂ levels.

Globally, the calculated total emissions of methane are almost in tune with the total sinks, where it not for the fact that calculations have been underassessing the massive methane emission leaks from the oil and gas supply chain, according to a recent study published in *Science* (Alvarez et al. 2018). It is of primordial importance to point out that methane has a short lifetime and can thus still be mitigated, while the more worrying effect is related to CO₂, which is out of control.

The conventional metric viewing methane as many times more harmful than CO₂ is misleading, not in the least because the kinetics of at-

atmospheric stabilisation are very different. Stabilisation of methane can be obtained by a drop of 30%, whereas CO₂ can only be stabilized upon a massive reduction (80%), whereby the lifetime of the former is in the order of 10 years and that of the latter of hundreds of years. Nonetheless, cows are usually taking most of the blame. Traffic, interestingly, seems to get away with it, although the latter largely drives CO₂ levels and has been increasing spectacularly over the last decades. And what is worse: traffic's impact on CO₂ levels is expected to upsurge in the coming years, as both air and land traffic will continue to develop, especially in emerging countries. Not only do methane emis-

sions have to be put in perspective, analysis should also take into account regional variability. In the US, for instance, direct emissions by livestock have been estimated at 4% by EPA, far below the impact on GHGs by transportation (28%), electricity (28%), or industry (22%). Taken ad absurdum, an elimination of all US livestock would only result in a 2.6% reduction in the country's GHG emissions, corresponding to a global difference of only 0.4%. Furthermore, the presence of large amounts of ruminants on US territory is not even a recent phenomenon. Far from that: over 60 million bison must have been roaming the North-American plains before the 19th century. To-

day's cattle produce more GHGs than the native bison but maybe not all that much.

It is worth mentioning that the US also harbours a massive population of pets, which rely on feed that creates an environmental impact equalling 25-30% of that of animal production. Understandably, almost nobody dares to put the latter sensitive issue on the table when arguing for a drastic reduction in meat consumption. Neither is it being stated that going vegetarian in an industrialized country will not cut your GHG emissions all that much: not the often-promised 50% but more likely 4% (or even only 2% as "rebound" effects need to be accounted for as well).



Things become even more problematic for anti-meat campaigners when GHG emissions are expressed on a basis of essential amino acids instead of weight (which is a common but meaningless metric) or energy density (which overlooks nutritional quality). Not only would the impact of crops such as rice and cauliflower then exceed the one of beef, even the production of peas would become more emissive than the one of pork or chicken. Nutrient density matters – which is conveniently ignored – and animal products are by far the most nutrient-dense and nutrient-complete foods in the human omnivorous die-

tary spectrum. So why is that rice is never blamed for damaging the environment, notwithstanding the fact that its nutritional value is very low in comparison to meat and its cultivation is a main driver of methane emissions too (10% of the global anthropogenic methane production)?

Although industrialized countries have been effectively reducing their methane output from cattle during the last decades, developing countries have been witnessing an increase. A 30% reduction can nevertheless be achieved globally if all producers would adopt the practices used by the 25%

most efficient ones. Several options are available, from the use of feed additives to regenerative grazing. Interestingly, the latter may even create a net emissions sink, by drawing more carbon into the soil than the methane produced by the cows. Optimized deployment and management of ruminant herds may thus not only contribute to a more sustainable food system based on the principle of soil carbon sequestration, but also by facilitating the provision of ecosystem services. In line with the vision of the FAO, policy makers need to acknowledge that “the livestock sector should be part of any solu-



tion to climate change" (my emphasis), highlighting the global importance of animal husbandry, contributes to the livelihoods of innumerable rural farmers, and has the potential to increase educational attainment and to reduce gender inequalities in developing countries.

Although livestock indisputably contributes to the emission of greenhouse gasses into the earth's atmosphere, it is unfair to depict this long-standing fundament of human civilization as the main cause for climate deterioration. A single return flight from Rome to Brussels generates much **higher emissions than the annual consumption of meat and cold cuts of a single person**, so can we just blame prosciutto while organising our next city trip? The real problem we need to face is an unpopular one: hyperconsumerism and an unbridled exploitation of fossil fuels. Burning

of the latter is brutally releasing enormous amounts of carbon – that had been sequestered for millions of years – into the atmosphere at a yet unseen rate. Instead, animal products are now used as a convenient scapegoat, rather than as respected contributors to healthy and sustainable diets, whilst the root causes of climate change remain mainly undressed.

In the meanwhile, **multinationals and venture capital funds have discovered the gold mine of the "plant-based" hype**, which mostly translates into abominable imitations of meat and dairy products. Easy profit is generated through the ultraprocessing of cheap ingredients (protein isolates, starch, and oil), generated from biodiversity-obliterating monocultures through the application of fossil fuel-derived fertilizers and by depleting valuable topsoil. For now, the public anti-live-

stock narrative needs to be maintained, so have decided the powers that be.

Let me be clear: it is our moral obligation to address any food production system that has detrimental effects on the environment. That is true for certain livestock systems, as well as for certain crops, of which some are particularly devastating indeed (cf. the cultivation of avocados in Mexico and the greenhouse apocalypse in Almeria). **Distorting the data for ideological purposes is scientifically dishonest and socially irresponsible.** More importantly, rather than focusing on sustainable diets as such, we urgently need shift the attention to lifestyles. Unfortunately, the growing influence of ideological agendas, the perverting interventions by vested interests, and the contemporary post-truth environment do not make the debate any easier.

Source: <http://carnisostenibili.it/en/can-cows-cause-more-climate-change-than-cars/>

* After having studied Bio-engineering Sciences at Ghent University (1992-1997), prof. Leroy obtained a PhD in Applied Biological Sciences at the Vrije Universiteit Brussel in 2002, where he continued his academic career at the research group of Industrial Microbiology and Food Biotechnology (IMDO) as a post-doctoral fellow of the Research Foundation Flanders (FWO). Since 2008, he holds a professorship in the field of food science and (bio)technology. His research primarily deals with the many ecological aspects and functional roles of bacterial communities in (fermented) foods, with a focus on animal products. In addition, his interests relate to human and animal health and wellbeing, as well as to elements of tradition and innovation in food contexts.

2

HOW TO CALCULATE THE ENVIRONMENTAL SUSTAINABILITY OF FOOD³¹

When we talk about sustainability, very often we tend to deal mainly with the environmental issue. However, it is clear that when we talk about food, and especially about what derives from animal production, the analysis must be complete and must also include other aspects, as is being undertaken with this report.

Remaining still in the environmental field, it is important to clarify some aspects of methodology to avoid the indicators being used in an inconsistent way relative to their purpose, reaching results and conclusions that are not completely correct. A little study on some of these aspects can be useful, referring to specific texts for further information.

2.1 Are impacts all the same? The importance of the context

Very often within the term “environmental impact” two phenomena are confused which, in fact, are clearly distinct: it would be more correct to divide between environmental aspects and impacts. **An environmental aspect is any interaction between a human activity** (for example a production process) **and the environment, while the environmental impact is the alteration (positive or negative) that the environment undergoes**³². The introduction of pollutants into a river is an environmental aspect, but the damage to aquatic organisms caused by the substances released is an environmental impact. The difference between cause and

effect may seem to be a purely academic distinction, but in reality it is very useful to describe the next concepts better. In particular, it should be stressed that the relationship between environmental aspects and impacts is not always obvious and can be influenced by different issues.

One is **time**: under certain conditions, the environment has the ability to dispose of the effects of pollution immediately and to return (almost) to its initial state. However, this natural phenomenon has limits: when the environmental aspects are excessive and too pressing, the ability of “self-repair” comes less and the environmental impact manifests itself³³. Almost like when alcohol is consumed: this does not create problems if the doses and frequencies of consumption are such as to allow the body to eliminate this form of “pollution”. When consumption is instead exaggerated (as in the case of environmental aspects that are too frequent or too large), then you get drunk (high impact) and sometimes the damage is irreversible.

Then there is the **context**, i.e. the local conditions in which the environmental aspects are manifested, which is fundamental for the quantification of the damage (impacts) generated: if a production process is characterised by repeated emission of 10 grams of pollutant in water, the relative impact will be very different if this happens in a small mountain lake or in the middle of the Atlantic Ocean.

Other phenomena that influence the dif-



ference between aspects and impacts are the **chemical-physical and biological mechanisms** that occur in the environment following the release of a pollutant. This is the case of fertilisers for example: once nitrogen is supplied to the soil through their use, the biochemical reactions of the soil lead to the formation and release of nitrous oxide (N_2O) into the air, which has a far greater impact than the initial nitrogen fertiliser.

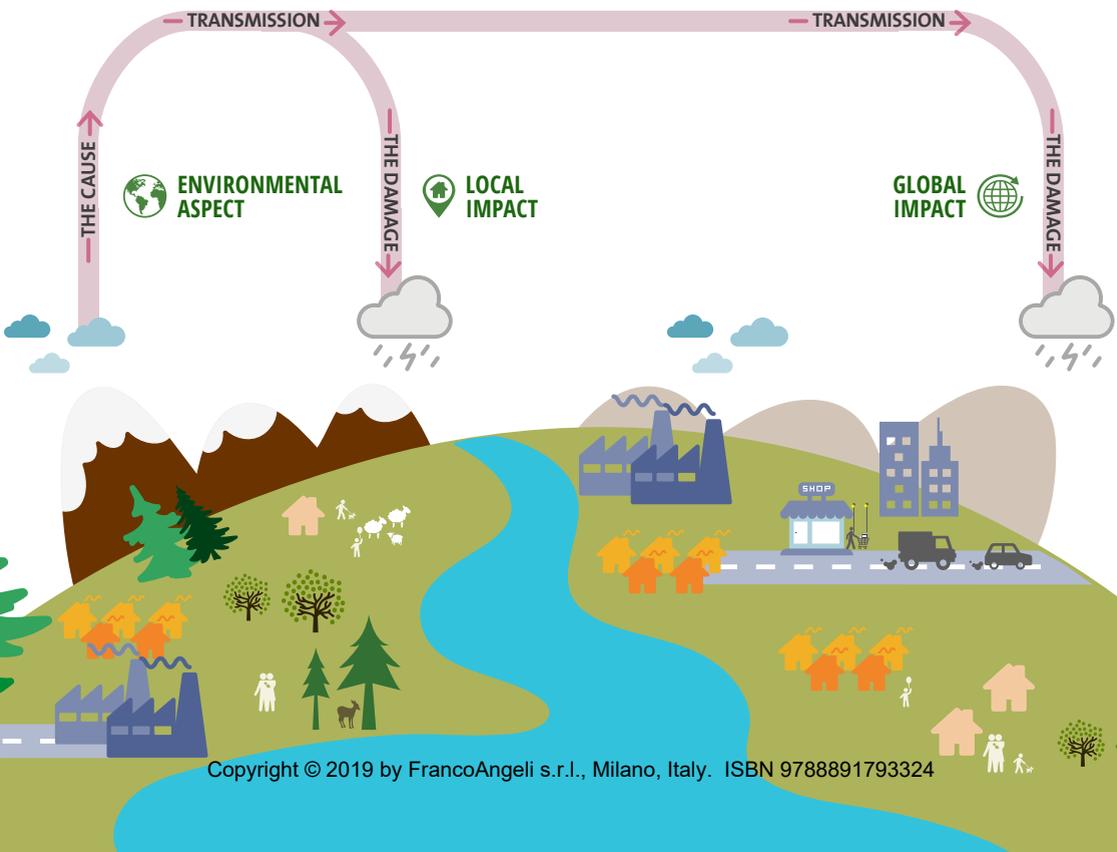
2.2 Local and global impacts

An additional variable to consider is the distance between the appearance of the environmental aspect and the damage generated.

If, for example, the machinery of a large production plant generates noise in places very distant from each other, the environmental aspects (therefore the noise) will not add up and every machine will

GLOBAL AND LOCAL IMPACTS CAUSE OR EFFECT

“ THE ENVIRONMENTAL ASPECT IS THE CAUSE, THE ENVIRONMENTAL IMPACT IS THE EFFECT (THE DAMAGE) ”



cause inconvenience (the damage, therefore the environmental impact) only to neighbouring people. In this case we talk about **local** impacts. Instead, when the environmental aspect is the consumption of a global natural resource, such as oil, or the release of pollutants that reach the atmosphere, such as CO₂, the entire world population is damaged. In this case we talk about **global** impacts.

2.3 How to calculate and interpret environmental indicators

These methodological premises are useful for supporting subsequent investigations. A fundamental criterion to follow

is certainly the difference between global and local aspects, especially for the methods of calculating and interpreting indicators. The global aspects (the most famous of all is certainly the greenhouse effect) are normally calculated with the approach of the **Life Cycle Assessment (LCA)** which plans to analyse all the phases of production of a food from the cultivation of raw materials up to distribution and consumption. This methodology, regulated by the international standard ISO 14040, provides in fact the sum of all the impacts generated in each single phase regardless of its position in the world, and is, therefore excellent for calculating the indicators that refer to global impacts.

Instead, when we move towards the analysis of local impacts, such as the use of water or phytosanitary substances in agriculture, the LCA approach has some limitations because the sum of local impacts may not be significant and lead to conclusions inconsistent with reality.

The most typical example of this possible inconsistency is that of water consumption. The total value of water consumed in an articulated process is not significant if it does not refer to local conditions, such as the availability of water. In other words, it is very clear that limiting the analysis to the data alone the answer to the question “what impacts more, the consumption of 10 litres of water in Israel or 20 litres in Sweden?” could reach questionable considerations.

The ideal solution is therefore the construction of a set of global and local indicators each of which must be interpreted coherently to its scientific significance.

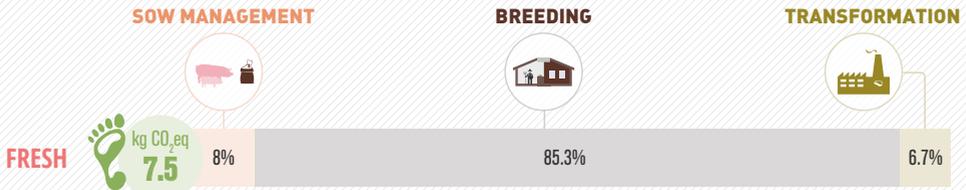


ENVIRONMENTAL IMPACT	DESCRIPTION	GLOBAL OR LOCAL IMPACT?	INSTITUTE/PROTOCOL REFERENCE
CLIMATE CHANGE [kg CO ₂ eq]	The greenhouse effect is a natural phenomenon due to the presence of some gases in the atmosphere. The main emissions of agri-food chains are carbon dioxide deriving from the use of fossil fuels, methane from enteric fermentations, nitrous oxide resulting from the use of nitrogen fertilisers.	GLOBAL	Intergovernmental Panel on Climate Change, 2013 ISO 14067 www.ipcc.ch
USE AND POLLUTION OF WATER [litres]	The use of water in the agri-food sector is relevant both for the volumes consumed and for eventual groundwater pollution.	LOCAL	ISO 14046
GROUND OCCUPATION [global m ²]	The food production chain involves the occupation of the soil during the agricultural cultivation phase of the raw materials as well as for the breeding farms.	GLOBAL when all components of the indicator are taken into account LOCAL when analysing specific aspects	Global Footprint Network www.globalfootprint.org
EUTROPHICATION [g PO ₄ ³⁻]	Eutrophication is an impact that involves an excessive amount of nitrogen in the environment (usually in water) with damage to flora and fauna. The main cause is due to the use of nitrogen-based fertilisers (natural or chemical).	REGIONAL	Evaluation method usually used is based on Heijungs's stoichiometric procedure (1992)
CONSUMPTION OF NON-RENEWABLE RESOURCES [MJ]	This impact refers mainly to the consumption of fossil fuels such as gas and oil that are used in the production of electricity and as traction fuel.	GLOBAL	Frischknecht, 2002
ECOTOXICITY [CTU, Comparative Toxic Unit]	This impact is generated by the release of chemicals that can pollute air, water or soil with damage to the ecosystem, flora and fauna. The substances responsible for this impact are predominantly the agro-drugs used in agriculture.	LOCAL	UNEP-SETAC Life Cycle Initiative www.usetox.org

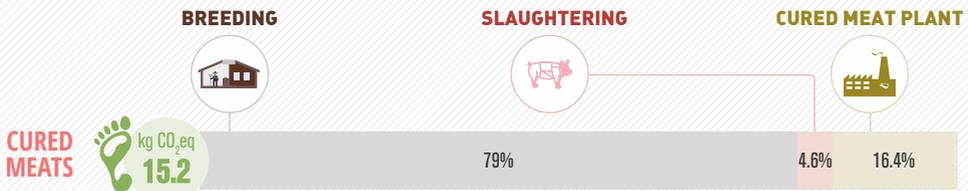
The main environmental impacts of agri-food supply chains

THE CARBON FOOTPRINT OF THE MAIN TYPES OF MEAT

PORK MEAT

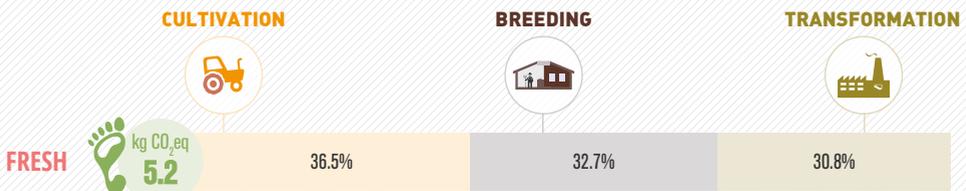


Source: BCFN, 2015



Source: BCFN, 2015

POULTRY MEAT

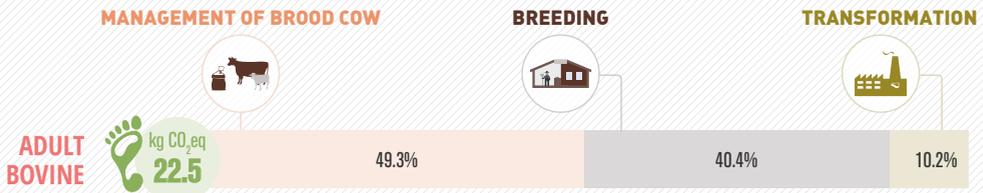


Source: BCFN, 2015

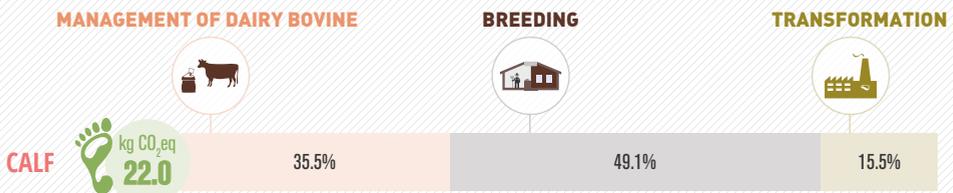
The impacts of the meat supply chain are more concentrated in the **management of breeding farms** and in the **cultivation of feeds** that make up the rations given to the animals; in the case of fresh pork and beef meat, part of the impact also derives from the respective management phases of the sow and the brood cow.



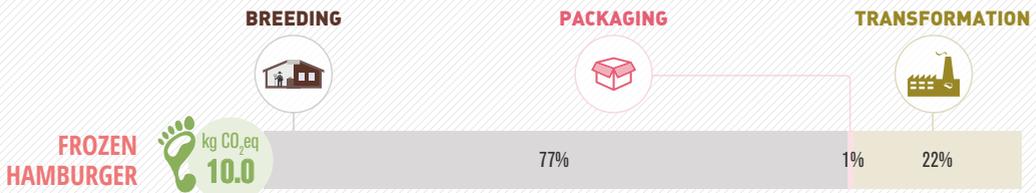
BEEF



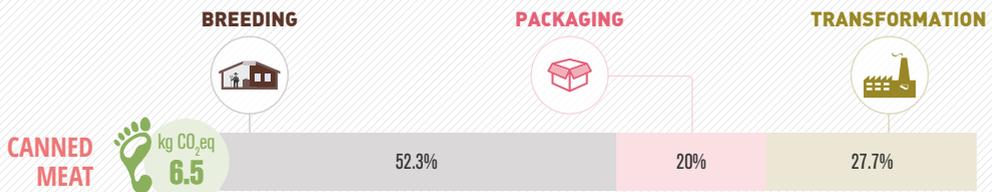
Source: EPD COOP n. S-P-00495, 2016



Source: EPD COOP n. S-P-00496, 2016



Source: EPD INALCA n. S-P-00711, 2018



Source: EPD INALCA n. S-P-01293, 2018

Industrial processing (intended as slaughtering, transformation and meat packaging) and distribution have a limited impact, greater only in the case of more elaborate foods such as cured meats or canned meat.

A METHOD TO AGGREGATE IMPACTS THE CASE OF ECOSYSTEM SERVICES

The need to simplify the messages on environmental impacts and to maintain the scientific rigor in the calculation of the indicators does not always allow us to find a univocal solution. Especially when global and local indicators must be put on the same level because in many cases considerations can be of an opposite nature. For this reason, there are many attempts to find aggregated indicators aiming to simplify communication with the use of a single value.

One of the most recent and interesting methods is that of ecosystem services defined in 1997 by the economist Robert Costanza which starts from a concept that originates from the economy of the environment: that of natural capital defined as "the entire stock of natural assets - living organ-

isms, air, water, soil and geological resources - that contribute to provide goods and services of value, direct or indirect, for humans and that are necessary for the survival of the environment from which they are generated"³⁴. In a nutshell, the assessment of ecosystem services aims at transforming the impacts, be they local or global, into an economic value in order to then aggregate the value into a single datum which represents the "environmental cost" of the process.

From a methodological point of view, the value of impacts is calculated by assuming a "replacement cost" of natural capital. To do this we consider, for example, the market value for the purchase of carbon credits in the case of greenhouse gas emissions, the cost of purification of

the chemical elements that contribute to eutrophication and the average cost of water supply for water consumption for company and breeding farms. Depending on the actual organisational conditions of the supply chain, other methods for estimating environmental costs could be adopted. In all cases, especially for local impacts, costs represent the real local conditions and therefore permit the focus of environmental impacts in the local geographical conditions of reference. In theory, the monetisation of the various impacts could make it possible to treat this cost as a budget item, to work to reduce it, to decide whether to internalise it in the company costs and, once reduced to the minimum terms, start local interventions of compensation.



2.4 The measurement of water use

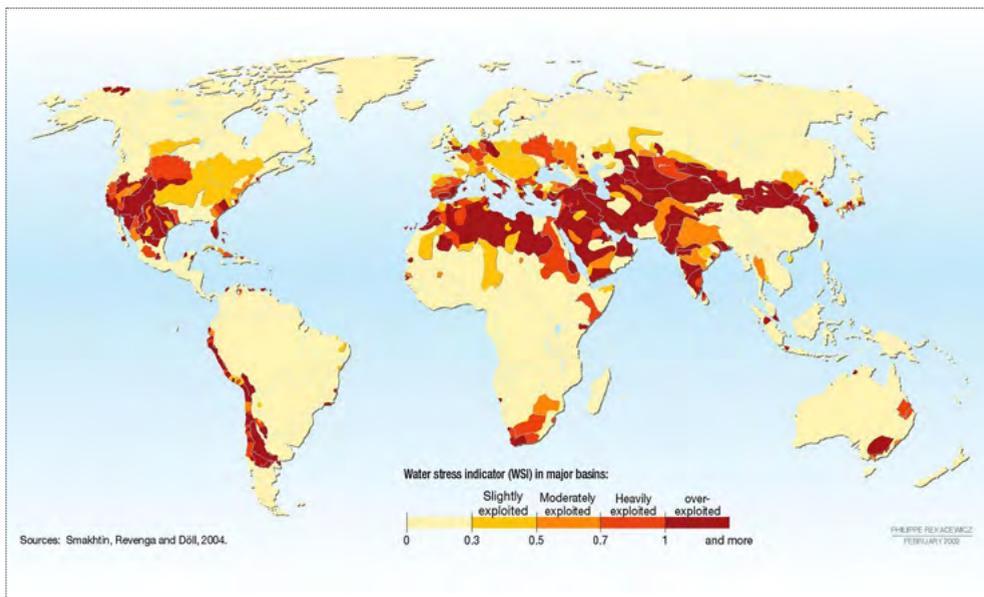
One of the most discussed environmental aspects of agricultural production and farming concerns water. This aspect must be analysed under two different points of view: on the one hand the volumes used must be considered, on the other the level of the contaminants released.

Each of the two aspects, which should always be analysed in a combined way, is checked and measured using different evaluation parameters. While the quality of water has historically been subject to greater controls (for example, the annual publication of the National plan for the research of residues of the Ministry of Health), the volumes consumed have begun to collect interest and become el-

ements of communication. The need to provide the consumer with synthetic and comprehensible information has consequently pushed towards the definition of methods and protocols aimed at the calculation of aggregated indicators.

The most widely used approach is to relate the **direct consumption of water with local availability**, transforming a consumption data into a reduction in availability, the real form of impact.

To do this there are different methodologies that all start from the concept of **water scarcity** (defined as the impossibility of having adequate amounts of water compared to the needs) and **water availability** (i.e. the real availability of water, accessible both from the qualitative and quantitative points of view).



Map relating to areas subject to lower or greater water stress. A value close to zero indicates an area that is not subject to water stress; numbers close to or greater than 1 indicate areas where the actual availability of water - usable at affordable costs - constitutes a problem.
Source: UNEP (Smakhtin V., Revenga C. and Doll P., 2004)³⁵.

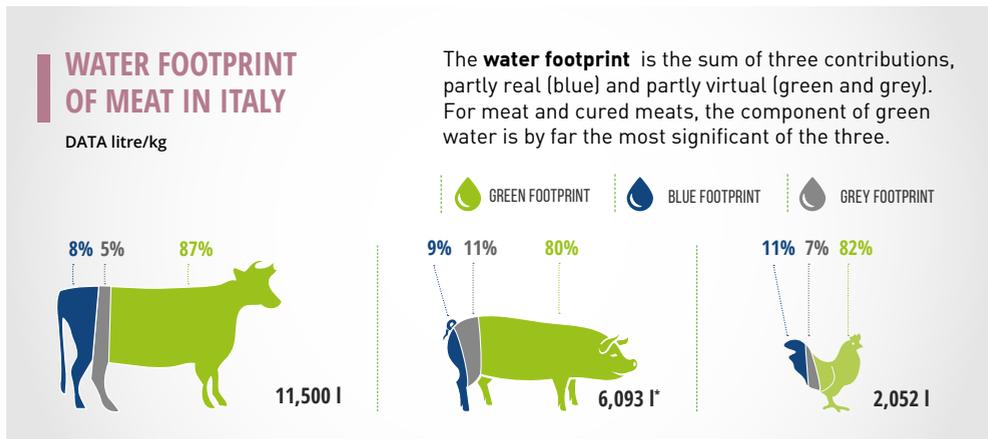
One of the most widespread methods of calculation is the one concerning water resource depletion, developed by the Joint Research Centre (JRC) of the European Commission, whose purpose is to evaluate how much water consumption in a specific geographical area actually affects the exhaustion of water resources in that area³⁶.

This method, among other things, is promoted by the European Commission as part of the initiatives to calculate the environmental footprint of products (PEF, Product Environmental Footprint) and organisations (OEF, Organisation Environmental Footprint).

In detail, the calculation is based on the factors provided by the **“Ecological Scarcity”** method³⁷ and plans to multiply the water consumption of the process under analysis for a characterisation factor derived from the ratio between total consumption and **availability in the reference region (low, medium and high)**. The indicator is expressed in an equivalent volume of water and is based on the factors reported in the study by Frischknecht et al. (2008)³⁸.

An example of calculation: the impact of beef

In this analysis it was decided to use the method suggested by the JRC³⁹ to “weigh” the values of direct water consumption⁴⁰. The work is to be considered preliminary because it is based on the hypothesis, not always correct, that the whole production chain (cultivation, breeding and processing) develops in the analysed region, and that therefore all the water of the final product is consumed in the same country. This “weighing” makes it possible to better correlate the withdrawal of water with the real “damage” made to the water availability in a specific geographical area. In regions where there is a problem of water scarcity, like India, the meat production chains are effectively impacting in quantitative terms to the point that the “weighted” water footprint becomes greater than the one calculated. When the production chain is instead located in areas where there is water availability, the environmental damage is less: as is the case of Argentina or Ireland that are, among other things, countries with a large meat production.



Source: Mekonnen M.M., Hoekstra A.Y., 2010. * The figure refers to the heavy pig (160 kg, 9/11 months of age) while the most common pig abroad weighs 80/100 kg (5/7 months of age)

WATER FOOTPRINT NETWORK

Most of the literature data on the water footprint of products (food and otherwise) currently available and used in communication have been published by the Water Footprint Network (WFN) or by different authors who often refer to the calculation methodology developed from the same network.

The Water Footprint Network (WFN)⁴¹ was the most widely used protocol for accounting for the water footprint of products and processes until the publication of the ISO 14046 standard and new methodologies for calculating impacts related to water usage (Ecological Scarcity, Pfister, AWARE, to name a few) have integrated the approach with the weighing of water consumption on the basis of real availability at the production site, providing a more complete and contextualised key of interpretation. Another aspect "corrected" by the new methods has been the evaluation of **the water evapotranspired by plants (the green water) which consisted of more than 90% of the impacts.** This contribution was on the one hand separate from the calculation of the direct indicators, on the other hand

modified with the introduction of methods aimed at calculating the differential between the evapotranspiration of the crop and the natural reference of the same area.



Green Water

The **green water** footprint is a characteristic of products of agricultural or forest origin and represents the quantity of rainwater that crops use in their production cycle to live and grow. This quota represents the quantity of "evapotranspired" water, i.e. that passes from the ground to the atmosphere both for the evaporation of the soil moisture, that is stored in the surface layer of the soil and because of the transpiration of the plants. Not all the meteoric water is exploited for reasons related to the particularities of the soil, the needs of the plants and the characteristics of the root systems. **The green water footprint, therefore, includes only the volumes of rainwater that are retained by the ground and are available to meet the needs of crops,** calculated according to the type of crop, weather-climatic area and

average annual rainfall.



Blue Water

The blue quota (**blue water**) represents the amount of water taken from a body of water (rivers, lakes, aquifers) that is actually used in the production process and does not return, from downstream of the process that used it, back to the source from which has been withdrawn. If therefore, for example, water is taken for a refrigeration plant and subsequently re-introduced into the environment, the blue water footprint consists only of the part eventually evaporated during the process.



Grey Water

Finally, the grey component (**grey water**), is defined as the volume of water that is theoretically necessary to dilute the contaminants present in the water leaving the system (such as that which leaks from a cultivated field or from an industrial process) if returning the water back to its original quality is required. In practice, the higher the level of pollution generated, the higher the grey footprint will be.

WATER FOOTPRINT OF BOVINE MEAT WEIGHTED WITH SCARCITY INDEX

Source: Mekonnen M.M. et al. (2010); Data related to boneless Bovine cuts, fresh or chilled

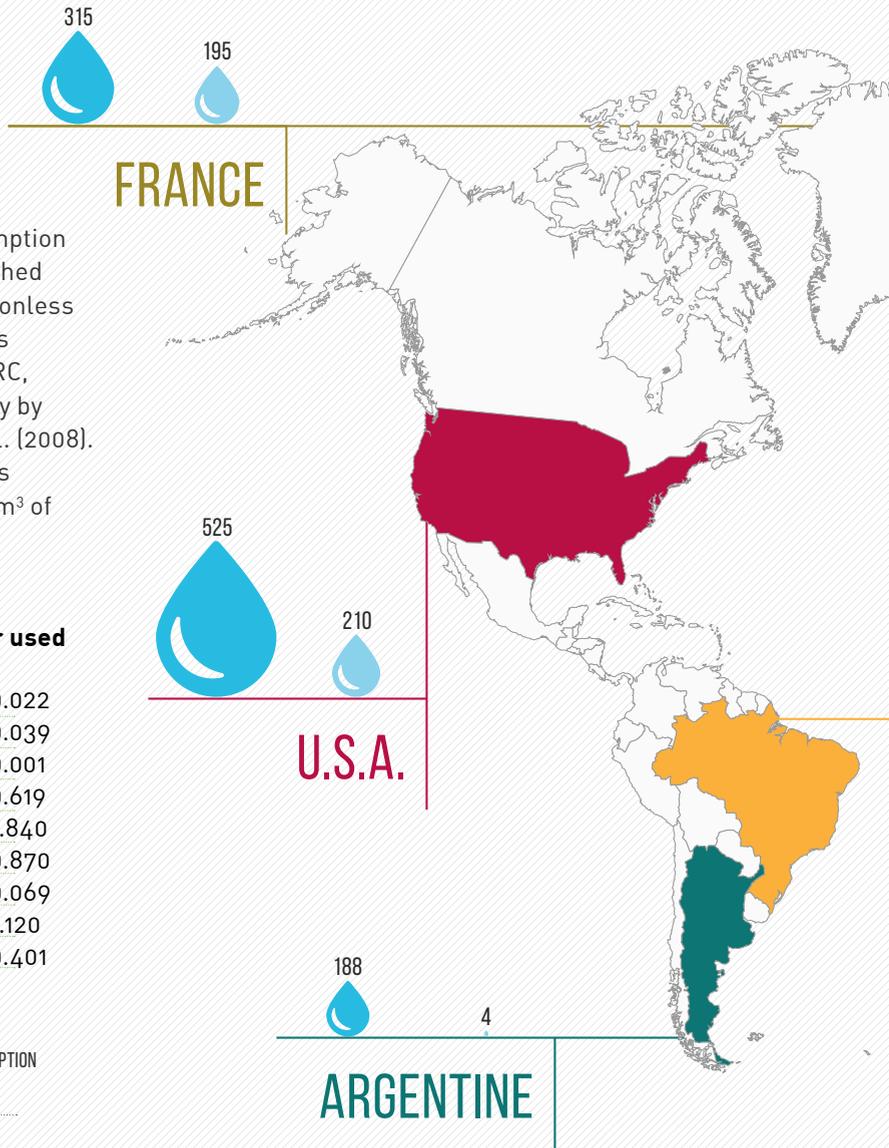
The direct consumption of water was weighed using the dimensionless conversion factors provided by the JRC, based on the study by Frischknecht et al. (2008). The correct values are expressed in m³ of equivalent water.

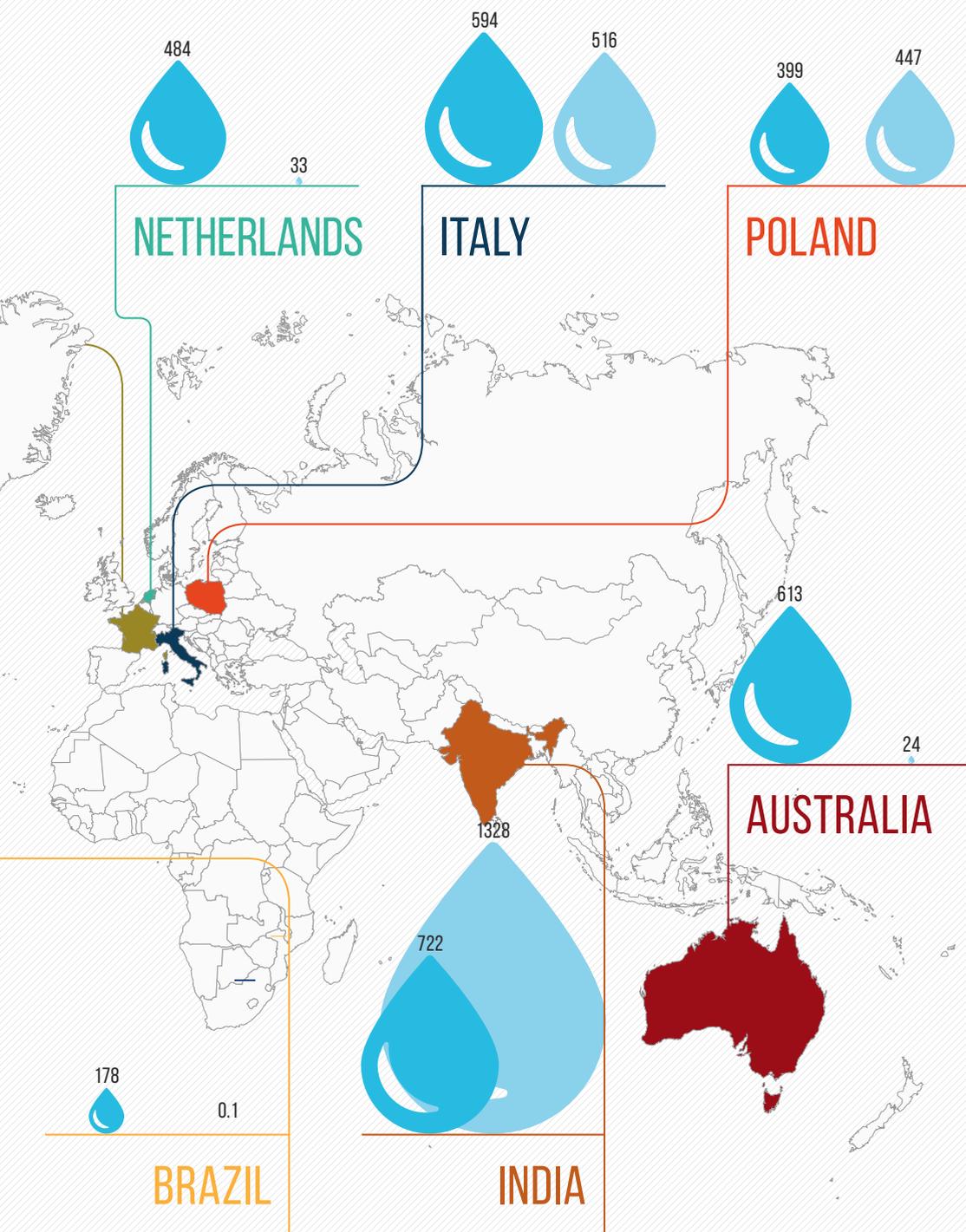
Conversion factor used

Argentina	0.022
Australia	0.039
Brazil	0.001
France	0.619
India	1.840
Italy	0.870
Netherlands	0.069
Poland	1.120
USA	0.401

 DIRECT WATER CONSUMPTION
(LITRES /KG)

 NORMALISED DATA
(LITRES EQUIVALENT/KG)





THE ISO 14046 STANDARD

The term Water Footprint was also taken from the ISO 14046 standard, published in 2014 with the aim of defining the guidelines for assessing the water consumption of a system starting from an

LCA-type analysis. The ISO standard does not refer to the concept of virtual water or to the distinction between the green, blue and grey water footprint; it is suggested, however, to take into consid-

eration the quantity of polluting substances present in the flows and give them accountability in the representation of impacts with environmental indicators.

THE AWARE METHOD

The AWARE (Available WATER REmaining) method, developed by the WULCA⁴² working group, aims to provide the sector's operators, both in the industrial and academic fields, with an instrument to evaluate, compare and communicate the environmental performance of products regarding water use. This method has also recently been chosen by the International EPD System[®] as a reference for calculating water scarcity among environmental indicators reported in the product's environmental declarations. The AWARE method measures the "potential for deprivation" of water, for both humans and ecosystems, starting from the assumption that if less water

remains available the greater the likelihood is that another user in the same area will be deprived of it (Boulay et al., 2016). The characterisation factors were first obtained by taking the difference between availability and water demand (AMD, Minus the De-

mand) in an area (expressed in $m^3 m^{-2} month^{-1}$). In a second phase, these values are normalised with the world average result and inverted, thus representing the relative value with respect to the average water consumed in the world.



THE METHOD OF THE NET WATERFOOTPRINT

(WFP_{NET})⁴³

Although it has been clarified that the contribution of evapotranspiration is insignificant to the discussion about the water impacts of agricultural production, in literature there are useful insights to improve its interpretation. In particular, one of the main critical aspects of the approach suggested by the

method Mekonen and Hoekstra (2012) is to calculate the value of green water in absolute terms. Some authors, for example Atzori et al. in 2016⁴⁴, proposed to evolve the original approach in the Net Waterfootprint (WFP_{net}) going once at a time to calculate the evapotranspiration differential between the

investigated crop and a reference situation (e.g. forest) that could be hypothesized for the geographical area of reference. In this way the indicator would represent the real impact induced by the action of man in the choice of the crop system.

$$\text{WFP}_{\text{net}} = \left(\text{ET OF CROPS} - \text{ET OF NATURAL COVERAGE} \right) + \left(\text{DRINKING WATER} \text{ and } \text{SERVICES} \right)$$



3 THE ENVIRONMENTAL IMPACTS OF THE DIET: THE ENVIRONMENTAL HOURGLASS

Meat and cured meats are among the foods with the greatest impacts per kilogram. This consideration becomes less clear if the comparison is made considering the quantities consumed in a diet consistent with nutritional advice. Trying to graphically represent this concept starting from the weekly consumption suggested by the nutritional guidelines and multiplying them by the average environmental impacts of the various food categories, an innovative graphic representation is obtained, similar to an **hourglass**.

A first edition of this presentation was published in 2013, by COOP Italy with a Book on the sustainability of branded beef⁴⁵: the hourglass, which was intended to propose a different reading of the relationship between diet and environmental impact, was reviewed and updated by the Sustainable Meat Project. The most important aspect that emerges from this representation is that, in a balanced weekly diet, the environmental impact of protein rich foods (meat, fish, eggs, legumes, cured meats) is comparable with the impact generated by foods of plant origin (fruit, vegetables). If taken in the right quantities, the various food categories have in fact a similar “environmental weight”, homogeneously distributed along the hourglass.

This reading allows to reinforce the consideration that **a balanced diet is not only useful for the interests of one’s own health, but also for the environment**.

3.1 The construction of the hourglass

Conceptually, the process required to build the hourglass is very simple: **the environmental impacts (per kg) of food are multiplied by the quantity consumed in a week, obtaining the environmental impact**. The criticality in the calculation lies in the data, both of impact and quantity of food, that are chosen. When it comes to fruit, for example, people’s food choices can be very different (from pineapple to apple) and with them the related environmental impacts. The same is true for the quantities of food, which obviously cannot be net and precise because, while remaining in the context of a balanced diet, people’s choices can be very different. For these reasons the hourglass calculation was made by hypothesizing different possible food selections, with the awareness that what is presented in this document is not the only possible representation: the combinations between consumption frequencies and favourite foods are almost endless.

Environmental impact data

The hourglass setting is made taking into account the global impacts of food, then calculated using the life cycle methodology. For this reason, the impact indicator taken into consideration is that of the carbon footprint that must be read with the limitations evidenced in the previous pages.

		CARBON FOOTPRINT
		DATA (kg CO ₂ /kg food)
MEAT. FISH. EGGS. LEGUMES	Fresh meat poultry/pork	4.6
	Fresh beef ⁴⁶	23.4
	Fresh beef - hamburger ⁴⁷	10.5
	Cured meats ⁴⁸	15.1
	Fish and shellfish	4.4
	Preserved fish ⁴⁹	4.4
	Eggs	3.8
	Legumes ⁵⁰ (Fresh or in cans)	1.7
	Dry legumes	1.7
MILK. YOGURT. CHEESE	Milk/Yoghurt	1.5
	Fresh cheese	9.3
	Seasoned cheese	9.3
CONDIMENTS	Butter	8.3
	Oil	3.1
CEREALS	Bread	1.1
	Bakery products	1.6
	Pasta	1.9
	Rice	3.8
	Potatoes	1.2
FRUIT. VEGETABLES	Vegetables	1.7
	Salad	0.6
	Fruit	0.5

The data used is for the most part from the database published by BCFN Foundation⁵¹ and includes both the production of the food and its cooking when necessary. In the cases of meats and cured meats, the more specific knowledge of the sector has allowed us to use more representative information of the Italian production reality. **In all cases, the approach used was to exploit public data by favouring the reconstruction of the calculations, rather than the precision of the results.**

How to calculate the weekly consumption: portions and consumption frequencies

The amount of food consumed weekly can be calculated from two pieces of information: **portions** (amount of food) and **frequency** (how many portions). As for the portions, it was decided to adopt what was suggested by the Italian Society of Human Nutrition (SINU) with the LARN published in 2012⁵². The aim is to provide operators in the nutritional surveillance sector with a practical, shared reference, useful to define diets for the various age groups or groups with specific nutritional needs (pregnancy, lactation etc.). In the hypothesis of keeping portions constant,

the frequency of consumption may vary according to food choices, but also to people's characteristics (gender, age, activities, etc.). To evaluate the variability of these options, three scenarios based on a different methodological approach were analysed: two of these (Scenario B and C), similar to last year, are based on INRAN's nutritional guidelines (now CREA - Food and Nutrition)⁵³; and the third on the Mediterranean Diet (Scenario A) suggested by the International Mediterranean Diet Foundation⁵⁴.

In the elaborations related to the INRAN guidelines, the foods belonging to the first category (meat, fish, eggs, legumes) have been organised in various ways, maintaining the suggested constant frequency of 14 weekly portions.

Regardless of the hypotheses adopted, it should be remembered that a balanced diet should not exclude any food; for this reason, alternative food models, such as the vegetarian one, have not been taken into consideration, as this elaboration does not fall within the scope of the document and would require medical skills that go beyond those of the authors involved.

SCENARIO A LOW

The Mediterranean Diet scenario involves a very low consumption of meat and cured meats (350 grams weekly) and greater consumption of fruit and vegetables.

SCENARIO B INTERMEDIATE

The intermediate scenario takes into account a moderate consumption of meat and cured meats, which reaches 450 grams weekly.

SCENARIO C HIGH

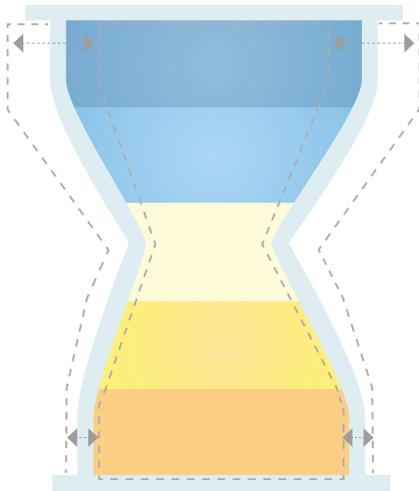
Always in compliance with the nutritional indications, this scenario foresees a greater frequency in the consumption of food of animal origin, reaching 550 grams of meat and cured meats per week.

			WEEKLY CONSUMPTION FREQUENCIES		
FOODS	g per portion (from LARN 2014)	A	B	C	
MEAT. FISH. EGGS. LEGUMES	Fresh meat poultry/pork	100	2	3	3
	Fresh beef	100	1	1	1
	Fresh beef hamburger	100	0	0	1
	Cured meats	50	1	1	1
	Fish and shellfish	150	3	2	2
	Preserved fish	50	0	0	0
	Eggs	50	3	3	3
	Legumes (Fresh or in cans)	150	0	0	0
	Dry legumes	50	4	4	3
MILK. YOGURT. CHEESE	Milk/Yoghurt	125	10	21	21
	Fresh cheese	100	2	1	1
	Seasoned cheese	50	2	2	2
CONDIMENTS	Butter	10	7	7	10
	Oil	10	14	14	11
CEREALS	Bread	50	35	35	35
	Bakery products	30	7	7	7
	Pasta	80	5	3	4
	Rice	80	2	4	3
	Potatoes	200	2	2	2
FRUIT. VEGETABLES	Vegetables	200	14	13	12
	Salad	80	7	1	2
	Fruit	150	21	21	21
Total meat and cured meats			350	450	550

The different environmental hourglasses

The analysis of the variability of food choices leads us to observe how, despite the different consumption levels, the hourglass profile does not vary substantially: in the case of the Mediterranean Diet, on the contrary, it emerges almost paradoxically that low-impact foods such as fruit and vegetables become more impactful than those of meat.

Compared to the last edition, there are some differences in the results partly due to the constant updating that occurs in the environmental data, partly for the revision of the portions whose weights have been modified to use a more updated source. For the construction of environmental hourglasses (relating to the carbon footprint and the water footprint) reference was made to **scenario B**.



“ **DESPITE MEAT BEING AMONG FOODS WITH THE HIGHEST IMPACT, BY UNIT WEIGHT, A BALANCED CONSUMPTION DOES NOT INFLUENCE SUBSTANTIALLY THE WEEKLY IMPACTS** ”

 CARBON FOOTPRINT HOURLASS THE THREE SCENARIOS kg CO ₂ person/week	CATEGORY	A	B	C
	MEAT. FISH. EGGS. LEGUMES	6.9	6.7	7.7
	MILK. YOGURT. CHEESES	4.6	5.8	5.8
	DRESSINGS	1.0	1.0	1.2
	CEREALS	4.2	4.5	4.3
	FRUIT. VEGETABLES	6.6	6.0	5.7
	TOTAL	23.3	24.0	24.6

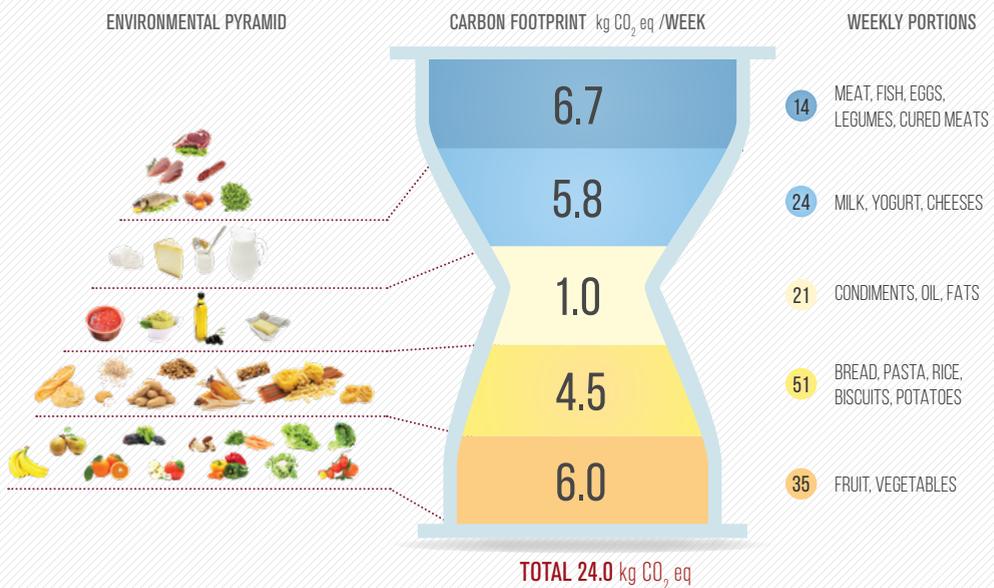


THE ENVIRONMENTAL HOURGLASS

CARBON FOOTPRINT

The Environmental Hourglass represents the carbon footprint of the foods consumed in a week following **scenario B**.

THE ENVIRONMENTAL HOURGLASS®



The Environmental Hourglass is built considering the consumption frequency suggested by INRAN (now CREA – Food and Nutrition) in the 2003 guidelines for an adult who needs 2,100 kcal per day, and the portions suggested by SINU in the guidelines published in 2012.

ENVIRONMENTAL IMPACT CALCULATORS

There are several calculators on the Internet that allow an approximate assessment of the impact of one's lifestyle on the environment. Some permit the calculation of the environmental load of the user by evaluating the whole lifestyle, others focus attention on nutrition. They are simple and immediate calculators, which attract the user for their easiness in compilation and interpretation, taking into consideration the essential aspects of daily living. The official Footprint Network calculator, **calculate**

your footprint⁵⁵, for example allows to calculate your "ecological footprint", i.e. how much biologically productive surface is necessary to sustain your lifestyle.

The questions asked by the computer concern food (consumption of meat, fish, eggs and dairy products, local products), lifestyle and habits regarding clothing, home (with relative energy costs and management of household waste) and means of transport used. The result is expressed in "planets" and divided into the different components of the Ecological Footprint.

The WWF calculator, **Make the difference!**⁵⁶, instead evaluates the environmental load of the user expressing it in mass of CO₂ equivalent, then in terms of Carbon Footprint. The overall impact of an individual is calculated starting from primary emissions (home and transport/travel sectors) and secondary emissions (food, purchase of goods and services, entertainment, etc.). The calculator asks the user what his habits are in home management, transport, supply and services, providing a final result in terms of tons of CO₂ equivalent per year.

The COOP calculator, the **Expenditure Footprint**⁵⁷, finally calculates the environmental impact of the user's eating habits on the basis of their weekly expenditure. In fact, it is possible to simulate the expenditure through the computer, referring to the main types of products that end up in the shopping cart and calculating the environmental impact in terms of Carbon Footprint. Multiplying the recommended quantities of each food that makes up a balanced diet (suggested by the INRAN nutritional guidelines (now CREA - Food and Nutrition) by its environmental impact, you get the average impact of the weekly diet. Once you have specified the number of family members and the days when shopping is done, you proceed to the selection of foods, indicating the relative quantities. The calculator compares the average impact of the weekly diet with that obtained from the inputs entered by the user and provides tips and suggestions of how to follow a healthier diet, highlighting how it is always necessary to consume in a balanced way all categories of foods.



FREQUENTLY ASKED QUESTIONS

IT IS TRUE THAT TO PRODUCE A KILOGRAM OF MEAT DIVERSE KILOGRAMS OF VEGETABLE FOOD ARE CONSUMED, POTENTIALLY INTENDED FOR HUMAN FOOD?

The feed intended for farm animals is mainly composed of a mixture which includes cereals (corn, wheat, barley) and legumes (such as soybeans) according to a diet that is established on the basis of needs related to the type and purpose of breeding. It should not be forgotten that for bovine breeding we use 80% of the plants (stem and leaf in the case of corn silage), that is not edible by humans.

Rations for animals are very often derived from crops that are not used for human consumption (corn silage, protein peas, pasture grass, alfalfa, clovers or hay). Ruminants, moreover, thanks to the microflora that dwells in the rumen, are able to transform the non-protein nitrogen present in foods into proteins of high biological value. At the same time, we are moving more and more towards the decrease, as far as possible, of the use of edible proteins for humans as livestock feed. To achieve these objectives, farms and feed mills work in close contact, in order to increasingly optimise the use of crop residues and by-products, trying new combinations that keep conversion efficiency equally as high.

IS IT TRUE THAT MEAT PRODUCTION IMPACTS MORE ON THE ENVIRONMENT THAN OTHER FOODS?

Yes, meat is one of the foods with the greatest environmental impact per kg. This is due to the fact that its production chain is undoubtedly the most complex. Unlike products of farm origin in fact, to produce meat, a "double passage" is necessary: first, food is produced for the animals, then the process of protein conversion is started during breeding. A very particular aspect, especially for the bovine supply chain, is linked to enteric fermentations generated during digestion: being mainly made up of methane, they represent a significant contribution to greenhouse gas emissions; however, some studies (Lauder A.R. et al., 2013) argue that the relative impact of methane on climate change is overestimated due to its short duration in the atmosphere respect to CO₂. Therefore, the question is not correct. As Paracelsus said, in fact, it is the dose that makes a poison: it does not make much sense to classify foods according to their impact per kg for two fundamental reasons. The first is that the production chains are extremely integrated and depend on each other, making it essentially impossible to think about the existence of agri-food production

without animal husbandry. The second is that if you follow a balanced food consumption, for example consistent with the Mediterranean Diet model, the weekly impact of the diet is not particularly disadvantaged by a moderate consumption of meat, cured meats and other foods deriving from animal supply chains. As represented by the Environmental Hourglass.

IS IT TRUE THAT THE FOOTPRINT OF BARN BREEDING IS HIGHER THAN THAT AT PASTURE?

The data circulating on the water footprint of meat (15,000 l/kg of beef) are those published by the Water Footprint Network (www.waterfootprint.org), which provide for the sum of three different contributions: **blue water**, taken from the water table or from surface water bodies, **green water**, the rain water evapotranspiring from the soil during the growth of crops, and the **grey water**, the volume of water necessary to dilute and purify the production water discharges. This method of accounting presents some critical issues, especially when one looks only at the sum of data: since the "green" contribution is generally the highest one, it happens that **pasture breeding** is that characterised by a **higher water footprint**. A second substantial criticality

is that, by examining the overall value and ignoring the local context in which production and breeding take place, the withdrawal of water is not related to the availability of that territory.

BARN BREEDING IS ACCUSED OF BEING A CAUSE OF WATER POLLUTION. IS THIS THE CASE?

Animal manure is very rich in nitrogen and its uncontrolled spreading on the soil could actually generate environmental problems to the water table. However, the Nitrates Directive sets a very clear limit to this problem by defining maximum pollutant thresholds that the land can receive depending on whether or not it is near vulnerable areas.

To overcome this problem, sewage, livestock waste and slaughter waste are increasingly used for the production of biogas and, therefore, of thermal and electrical energy. This happens thanks to biomass anaerobic digestion plants that are able to treat, in addition to the sludge products from sewage treatment plants, livestock and slaughterhouse waste such as rumen content and blood. The biogas produced is normally used by the same companies through cogeneration plants aimed at the combined production of electricity and heat with two advantages: on the one hand the **production of energy without use of fossil fuels**, on the other the reduction of waste to be treated. The result of anaerobic digestion (digestate) is a product suitable for use in agriculture (organic

fertiliser for organic production)⁵⁸.

WHAT OTHER PRODUCTS ARE OBTAINED FROM BREEDING FARMS APART FROM MEAT?

Meat production is only part of what is obtained from farm animals. Bags, shoes, medical devices and heart valves, or soaps, fertilisers, natural rennet and biogas: these are just a few examples of the enormous quantity of products and by-products which are obtained from the livestock sector. The amount of meat obtained from an animal to be used for human food consumption varies according to the type of animal. In the case of cattle, for example, the yield after meat stripping is about 33-35%, while for pigs the percentage varies from 49 to 52%. But since nothing of an animal is thrown away, over the centuries many ways have been found to valorise that obtained from farms.

The cow and sheep skin, just to give some examples close to everyone, is used for durable goods such as hides and leather, which in turn serve to produce shoes, handbags, belts or cover sofas and car seats. The bovine and pork fat, on the other hand, is used in the cosmetic industry to make soap or cosmetics. Smaller quantities, but of great importance, are used in the field of medicine. Bovine and pork provide the pericardial tissue used for the preparation of medical devices such as heart valves or medicines such as heparin, while bones and rind are very use-

ful in the pharmaceutical field for drug encapsulation. Natural rennet (the only coagulant allowed for the production of PDO cheeses such as Grana Padano and Parmigiano Reggiano) is produced by the dairy industry thanks to the abomasum of cattle, the last of the four cavities of which the stomach of ruminants is composed. Even chickens provide important products in addition to their meat. Like fat, used for the production of feed and, in increasing quantities, for the production of biodiesel.

IT IS TRUE THAT DIETS WITH A HIGH MEAT CONTENT PRODUCE MORE GREENHOUSE GAS THAN VEGETARIAN DIETS?

There is no doubt that meat is the food that, per kilogram, has a greater impact than foods of vegetable origin, so a dish based on animal protein impacts more than a vegetarian one. However, the judgment should not be done on a single dish, but on the life cycle of the product, which is very different between plants and animals (bovine: 18-25 months, chicken: 1-2 months, pig: 9-11 months, salad: 1 month, tomatoes: 2 months). In a balanced diet that involves the consumption of all foods, moderate consumption of meat does not substantially increase the environmental impact over a reference period of time, such as a week.

WHAT IS THE ENVIRONMENTAL HOURGLASS?

Proper nutrition should pro-

vide for a balanced consumption of all available foods. If you follow the consumption advice suggested by the Mediterranean Diet model, the average weekly impact of meat is aligned with that of other foods, for which the unitary impacts are lower but the quantities consumed generally higher. This is the concept represented by the Environmental Hourglass, obtained by multiplying the environmental impact of food (for simplicity the Carbon Footprint) for the weekly quantities suggested by the current nutritional guidelines INRAN, now CREA - Food and Nutrition. According to this representation, eating meat in just the right amount does not significantly increase an individual's environmental impact. After all, a sustainable lifestyle should also be measured by other choices such as mobility, energy consumption, clothing, free time habits.

ARE ZERO KILOMETRE PRODUCTS THE MOST SUSTAINABLE?

The topic of food distribution is interesting both for the social implications linked to the protection of local communities and traditions and for environmental ones. The concept of food at zero kilometre is in fact spreading, to which the equation "zero-kilometre product = product with low environmental impact" is associated. Also in this case a simplistic view of the problem can lead to interpretations that are not entirely correct. Focusing only on environmental aspects, once again considering the Carbon

Footprint in an exemplary way, we can easily demonstrate how the impact of food distribution is relevant only in very few cases. In fact, if it is true that the use of a truck involves a high CO₂ emission per kilometre, it is also true that the quantity of goods transported is high and therefore the impact per kilogram of product is rather limited. Given the low importance of transport, therefore, it is not always true that zero-kilometre productions have a lower environmental impact than traditional productions. In fact, it could happen that a "far away" system is more efficient from an environmental point of view than a "near" one, and therefore the impacts due to transport are largely offset by lower production costs.

This is the case, for example, of some agricultural raw materials that, when they are grown in production areas, make cultivation very efficient: strawberries in Sweden would require energy costs for greenhouses that would not necessarily make them less impactful than those grown in Romagna and transported by truck. This does not mean that local productions are not to be preferred, but it is important to observe how this choice is often associated with other (important) advantages, such as cultural, economic and territorial valorisation.

WILL THOSE WHO DON'T EAT MEAT SAVE THE PLANET?

Since the correlation between eating habits and environmental impacts is now demon-

strated by many scientific and popular publications, the question that arises is whether controlling and reducing one's food impacts can be considered "sustainable". In fact, it would be interesting to extend the concept of sustainability to the whole lifestyle, of which nutrition represents an important but not unique variable. More and more frequently it is heard said that becoming a vegetarian is the only way to save the planet. In fact, often, those who choose not to eat meat do so for environmental reasons, before even ethical reasons.

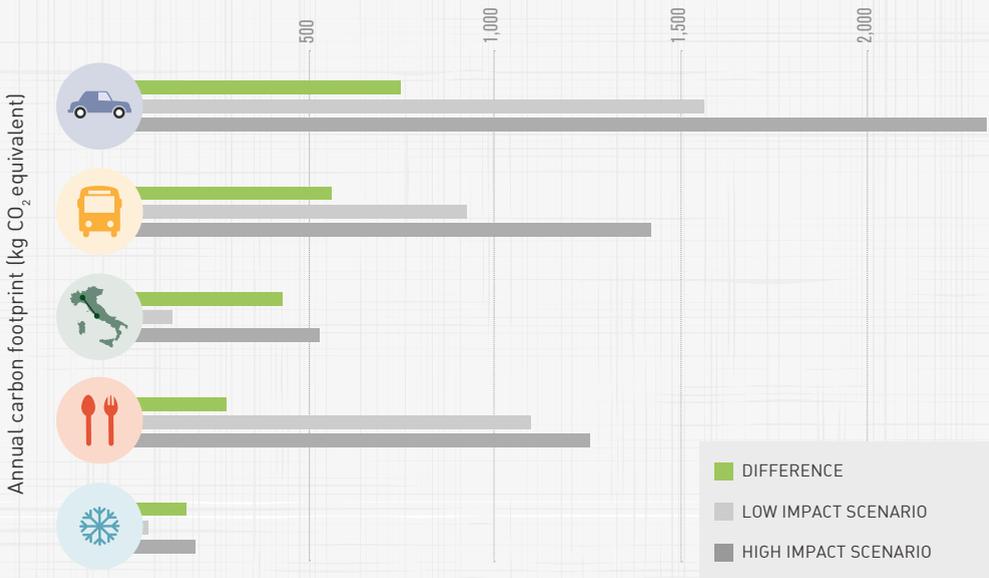
Yet eating meat in the right quantity or not eating it at all does not substantially modify one's own overall environmental impact. Other factors are more relevant to the overall environmental impact of an individual.

The choice of car, for example, can lead to important environmental repercussions: the difference in impact between a car with high horsepower and one with average power can be more than 500 tons of CO₂ per year, a value much higher than the potential benefit associated with food choices. From this data it is evident how "being sustainable" cannot be reduced to a single choice, but should be the result of a homogeneous behaviour, attentive to the many implications. A further observation is useful to understand how some of the cases presented are relatively simple to implement, as they are based on an immediate choice (such as the purchase of a car), while oth-

ers are more complex because they are linked to external factors or habits and behaviours that, like food choices, require different times. We

should therefore adopt a 360° sustainable lifestyle through simple actions, such as trying to reduce consumption in your home (so not overheating in

winter or overcooling in summer), choosing clothes suitable for the season.



CHOICES AND BEHAVIOUR	LOW IMPACT SCENARIO	HIGH IMPACT SCENARIO
Choice of car with which you travel 15,000 km per year	Car of 100 g CO ₂ /km 1.500 kg CO₂	Car from 150 g CO ₂ /km 2.250 kg CO₂
Travelling in the city: 40 km a day for 5 days a week and 48 weeks a year	Use of bus 890 kg CO₂	Use of your own car
Business trips Rome – Milan	6 train journeys 120 kg CO₂	6 plane trips
Food choices	Diet of 23 kg CO₂ per week	Diet of 25 kg CO₂ per week
Cooling an office	Use of a fan 12 kg CO₂	Use of an air conditioner 200 kg CO₂

Environmental impact per person, associated with some situations of "common life".
The presented data are calculated on the basis of indicative hypotheses

NOTES

- ¹ Internationally known Foundation funded by sail- or Ellen MacArthur and supported by industrial giants such as Google, H&M, Intesa Bank and the World Economic Forum
- ² Texts drawn up on the basis of the data available on the FAO website, livestock and environment section
- ³ Susanna Bramante is an agronomist, scientific divulgator and author and co-author of 11 scientific publications and numerous articles on human nutrition and its impact on health and the environment; in 2010 she obtained the title of Doctor Europaeus and Ph. Doctor in Animal Production, Health and Food Hygiene in Mediterranean Climate Countries. She runs GenBioAgroNutrition, "a blog supporting the Italian Agrifood, the Mediterranean Diet and Biomedical Research, against pseudo-scientific misinformation", which updates daily
- ⁴ Sonesson U. et al., 2009
- ⁵ European Commission, Guidelines for the use as feed of foods no longer intended for human consumption ([www.eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:52018XC0416\(01\)](http://www.eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:52018XC0416(01)))
- ⁶ The missing link - European Union action plan for the circular economy, COM (2015) 614 final, del 2.12.2015
- ⁷ EPA, Sustainable Management of Food, Food Recovery Hierarchy (www.epa.gov/sustainable-management-food/food-recovery-hierarchy)
- ⁸ Elferink E.V. et al., 2008
- ⁹ Wilkinson J.M., 2011
- ¹⁰ ISPRA, Rapporto 266/2017
- ¹¹ Global Feed LCA Institute (www.globalfeedlca.org/)
- ¹² Article 2 Directive 2001/18/CE of 12th March 2001
- ¹³ GMO techniques use genetic engineering to modify genes through a process of transgenesis, i.e. the insertion of a foreign gene (the transgene) into the genome of a living organism
- ¹⁴ World Health Organization, Food safety: 20 questions on genetically modified foods (www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/)
- ¹⁵ FAO, Weighing the OGM arguments: against, 2003 (www.fao.org/english/newsroom/focus/2003/gmo8.htm)
- ¹⁶ Barilla Center for Food&Nutrition - BCFN (www.barillacfn.com)
- ¹⁷ ISPRA, Report 231/2015
- ¹⁸ IPCC 2013, characterisation factor for methane (Methane, land transformation: 28 kg CO₂eq/kg CH₄)
- ¹⁹ IPCC 2006, IPCC Guidelines for National Greenhouse Gas Inventories, (10), paragraphs 10.4-10.5
- ²⁰ IPCC 2006, IPCC Guidelines for National Greenhouse Gas Inventories (10-11)
- ²¹ Fabbri C. et al., 2014
- ²² Primary data collected at the farms that bred adult cattle for COOP Italia in 2014. This data was used for the environmental product declarations, updated in 2015
- ²³ Official statistics on cattle and pig breeding (www.mangimiealimentari.it/articoli/1330-le-statistiche-ufficiali-sugli-allevamenti-di-bovini-e-suini/)
- ²⁴ TKN = nitrogen Kjeldahl; total Kjeldahl nitrogen (TKN, Total Kjeldahl Nitrogen) is defined as the sum of ammoniacal nitrogen and organic nitrogen
- ²⁵ Average values referred to 1000 kg live weight of the animal; the real values can vary considerably due to differences in feeding, age of the animals and breeding management
- ²⁶ The operations chosen are as follows: Natural gas: Electricity, natural gas, at power plant / IT U; Hydroelectric: Electricity, hydropower, at power plant/IT U; Biogas-powered CHP: Electricity, biogas, at Mini CHP plant, energy allocation/CH U; Medium energy mix IT: Electricity, low voltage, at grid/IT (energy mix according to IEA OECD 2014 data)
- ²⁷ Council Directive 91/676/EEC of 12th December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (www.eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:31991L0676)
- ²⁸ COOP, Environmental Product Declaration of the adult bovine brand COOP, Rev. 4 dated 05-12-2016 Registration No.: S-P-00495 - valid for 3 years
- ²⁹ Regulation (CE) n. Reg. 1774/2002
- ³⁰ Toldrà F. et al., 2012
- ³¹ From Marino M., Pratesi C.A., 2015
- ³² UNI EN ISO 14001: 2004 "Environmental management systems - Requirements and user guide"
- ³³ Holling C.S., 1973
- ³⁴ Definition provided by the Natural Capital Committee, UK in 2013 (www.gov.uk/government/groups/natural-capital-committee)
- ³⁵ Water Stress Indicator (www.grida.no/resources/5586)

³⁶ Further study of this calculation method is available in the Report: European Commission, Joint Research Centre, Institute for Environment and Sustainability. Characterization factors of the ILCD Recommended Life Cycle Impact Assessment methods. Database and Supporting Information. First edition. February 2012, pp. 15-16

³⁷⁻³⁸ Frischknecht R. et al., 2008

³⁹ This is the calculation method ILCD 2011 Mid-point + V1.07, present in the SimaPro[®] software; the calculation factors, specific for each country, are reported under the heading water resource depletion.

⁴⁰ There are other similar methods amongst which it is also possible to quote the one proposed by Pfister et al. (2009) (Pfister S., Koehler A., Hellweg S., 2009) Assessing the Environmental Impact of Freshwater Consumption in LCA, Environmental Science & Technology (43) pp. 4098-4104 using a water scarcity indicator (WSI) for which a system of characterisation factors is used based on the relationship between consumption and water availability in different countries

⁴¹ Water Footprint Network (www.waterfootprint.org)

⁴² The WULCA group www.wulca-waterlca.org received the mandate from INPECT SETAC Life Cycle Initiative (Global orientation project on environmental impact assessment indicators of the life cycle) to guide harmonisation and the creation of common consensus for the category of "water use" impacts

⁴³ Texts and images are taken from the article "How to correctly calculate water consumption of animal productions" by Giuseppe Pulina, Caterina Canalis and Alberto Stanislao Atzori published in the *Informatore Zootecnico*, N.8-2018

⁴⁴ Atzori A.S. et al., 2016

⁴⁵ COOP, The Sustainability of COOP branded beef - The economic, social and environmental impacts of the meat supply chain, published in November 2013 and available on www.e-coop.it

⁴⁶ The data reported here is the average Carbon Footprint data of the two types of meat, including cooking. The reference documents are the two environmental product declarations published by COOP and available on the website (www.environdec.com). For further details, refer to the bibliography at the end of the chapter

⁴⁷ Environmental product declaration of frozen hamburgers under the Montana brand. Available on the website www.environdec.com

⁴⁸ Confidential LCA studies (source: LCE)

⁴⁹ The same impact was assumed for fresh and preserved fish

⁵⁰ By hypothesis, fresh legumes, canned and dried, have the same impact

⁵¹ The BCFN source is the technical document supporting the Double Pyramid, 2015 version (BCFN, Double Pyramid 2015: recommendations for sustainable food) except in the case of vegetables, whose impact data derive from the technical document, 2014 (BCFN, Double Pyramid: food styles and environmental impact)

⁵² Quantitative standards of portions taken from: SINU 2012. Italian Society of Human Nutrition.

LARN Levels of Reference Assumption of Nutrients and Energy for the Italian population

⁵³ Nutritional guidelines developed in 2003 by the INRAN working group (Created since June 2015 "CREA - Food and Nutrition", acronym of Council for research in agriculture and analysis of the agrarian economy - Research Centre for food and nutrition), from the Ministry of Health and the Institute of Food Science of the University "La Sapienza" of Rome, with the aim of developing a type of diet towards which the citizen should be directed, advising the appropriate changes. Specifically, the recommendation was considered related to 2,100 kcal every day

⁵⁴ Bach-Faig A. et al., 2011

⁵⁵ Online calculator that allows to evaluate the ecological footprint and overshoot day, in function of the resources consumed (www.footprintnetwork.org/it/index.php/gfn/page/personal_footprint/)

⁵⁶ WWF Online Calculator (www.racconta.repubblica.it/wwf-calcolatore-co/main.php)

⁵⁷ Impression Spending, COOP (www.e-coop.it/coopco2/)

⁵⁸ Rossi L. et al., 2018

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 - Global Footprint Network: www.footprintnetwork.org
 - International EPD System: www.environdec.com
 - United Nations Environment Programme: www.unep.org
 - Water Footprint Network: www.waterfootprint.org



FOOD SAFETY AND ANIMAL WELFARE

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- ❧ THE CONTAMINATION RISK
 - ❧ CONTROLS AND INFORMATION FOR CONSUMERS
 - ❧ THE COMMUNITY FOOD ALERT SYSTEM
 - ❧ ANIMAL WELFARE

Introduction

MEAT AND CURED MEATS ARE COMPLETELY TRACEABLE, A GUARANTEE OF THEIR ORIGIN AND QUALITY

THE ITALIAN HEALTH CARE SYSTEM IS ONE OF THE MOST STRUCTURED IN THE WORLD, WITH 4,500 OFFICIAL VETERINARIANS INVOLVED

ANIMAL WELFARE IS IMPORTANT FOR ETHICAL REASONS, BUT ALSO TO ENSURE THE DEFENCE OF FOOD SECURITY AND IMPROVE MEAT QUALITY

The growing attention to the issues of food and its safety very often leads the media and social media to transform simple news into “food scandals”. The reading of these news should always lead to a classification in different spheres: there are the aspects actually related to consumer safety, those concerning economic frauds (e.g. non-organic food sold as organic, but still safe) and those related to animal welfare. Furthermore, when we talk about security, we must distinguish between real or presumed aspects: indeed, very often the withdrawal of food products is done according to the precautionary principle because there is a suspicion that food is characterised by potentially dangerous contaminations. In these cases, it is advisable to avoid creating unjustified alarmism because the real danger is normally very low if not zero. Italian consumers can rest assured: the quality and the food security, in Italy as well as throughout the European

*Union, do not represent only a regulatory cornerstone of the Union itself, but the real cornerstone of the community policy for consumer protection. In fact, the European strategy foresees the **prevention of any risk for food safety along the entire production chain** and is based on the so-called “**One Health**” principle¹: an integrated approach that **considers the links between animal health, health of products derived from them and human health to be indispensable**, to guarantee the latter a high level of life quality by protecting at the same time the health and welfare of the animals. The effectiveness of the controls is further strengthened by **traceability**, which allows to reconstruct and follow the path of a food from the consumer up to the primary agricultural production. **The Italian health care system is one of the most structured in the world**, recognised in Europe as a point of excellence thanks to the approximately **4,500 official***

***veterinarians** involved in the numerous checks and analyses in the field of meat safety and quality. The issue of security is closely linked to that of **animal welfare**. . Maintaining a state of good psycho-physical health in animals is in fact an indispensable requirement to guarantee them adequate living conditions, but it is also a crucial element in guaranteeing the safety and quality of the food that derives from them. The evolution of public sensibility has meant that starting from the Eighties this theme was widely dealt with by the community and national legislation, that establishes minimum welfare conditions to be respected: **in many cases a violation of these rules is considered a criminal offense in Italy**. For this reason, it was decided to keep these two aspects, apparently unconnected, in the same chapter of this document.*

1 THE CONTAMINATION RISK

When it comes to contamination, it is important to understand its origin. In general, the phenomena of contamination can be caused by the **use of drugs** in breeding or by **chemical and microbiological contaminations** that can occur in the production of feed, in breeding, in the transformation and distribution chain.

In the case of drugs, it is essential to divide between those banned and those admitted with a regulated use, also to eradicate some false clichés: the most frequent concerns, for example, the one concerning the use of growth hormones that have been banned for some time in all of the European territory. Amongst the regulated and widely discussed drugs are antibiotics that can be used, only after medical prescription, with precise usage amounts and for the sole purpose of treating sick animals. Their use must be limited in time; moreover, the animal cannot be slaughtered without having complied with the so-called “suspension period”, which guarantees respect of maximum residue limits (MRL) in slaughtered meat, established by law.

The presence of chemical substances may derive from possible contamination during the food cultivation phase: for this reason, the European approach to food control is very useful which originates at the beginning of the supply chain and puts under observation every phase of the transformation. Any microbiological contamination, finally, may be due to poor

management of the supply chain, distribution or, above all, domestic food preservation.

1.1 Antibiotic drugs

Antibiotics (from ancient Greek: anti, “against”, and bios, “life”) are molecules originating both from fungal and synthetic species that kill bacteria or inhibit their growth. They belong to the largest group of antimicrobial compounds, used to treat infections caused by microorganisms, including fungi and protozoa.

Since the Fifties of the last century, antibiotics have been a fundamental means for controlling infectious diseases in the veterinary sector, thus contributing to the improvement of animal welfare and product safety of animal origin foodstuffs. The benefits of using antibiotics are also countless for human medicine: many bacterial infections that up to 50 years ago could kill a person, such as pneumonia, are no longer a danger.

However, when the use of these drugs is excessive or not very controlled, it can trigger a phenomena of drug resistance by bacteria.

The phenomenon of the antibiotic resistance

The development of resistance is in itself a normal evolutionary process, a consequence of the genetic evolution to which micro-organisms encounter: when we assist an improper use of antibiotics,

however, the phenomenon of resistance accelerates due to the natural tendency of microorganisms to “defend themselves” from active ingredients contained in drugs. “Resistant” bacteria, even if they are harmless, can pass from one organism to another transmitting the resistance to a pathogenic organism of the new guest.

Since the Nineties, the phenomenon has always been more widespread, to the point that in the first Global Report on antimicrobial resistance, published by WHO in April 2014, antibiotic resistance is iden-

tified as a “**serious and potential threat to public health**”. The development of strains of resistant bacteria makes it indeed difficult to treat an ever increasing range of fairly common infections easy to catch, with the result that also the most common and simple diseases to cure, become potentially a lot riskier for health. To reduce this danger, in 2006 the European Commission **forbade the use of antibiotics** in breeding for non-therapeutic purposes (i.e. as growth promoters)² and has published guidelines for their correct use³.

EUROPEAN AWARENESS CAMPAIGNS

antibiotics primarily for human therapies. Among these, the main ones are the “World Antibiotic Week” promoted by the WHO and the European Antibiotic Day of the European Union, but also national information campaigns developed by individual member states.

Some of these are:

- **AUSTRIA** NAP AMR: The Austrian National Action Plan on Antimicrobial Resistance
- **BELGIUM** Antibiotics: use them correctly and only when needed!
- **DENMARK** Antibiotics: yes or no?
- **FRANCE** National Antibiotics Information Day
- **GERMANY** RKI: Antibiotic resistance
- **IRELAND** Under the Weather
- **ITALY** - AIFA (Agenzia Italiana del Farmaco): campaign “Without rules antibiotics do not work”
- ISS (Istituto Superiore di Sanità): Seventh Day of antibiotics: bacteria more resistant in Europe
- **ENGLAND** “Antibiotic Guardian” Public Health campaign England: toolkit and information material on antibiotics
- **HOLLAND** Antibiotic resistance

*Not just food: the various areas of diffusion of antibiotic resistance.
Source: European Antibiotics Day*

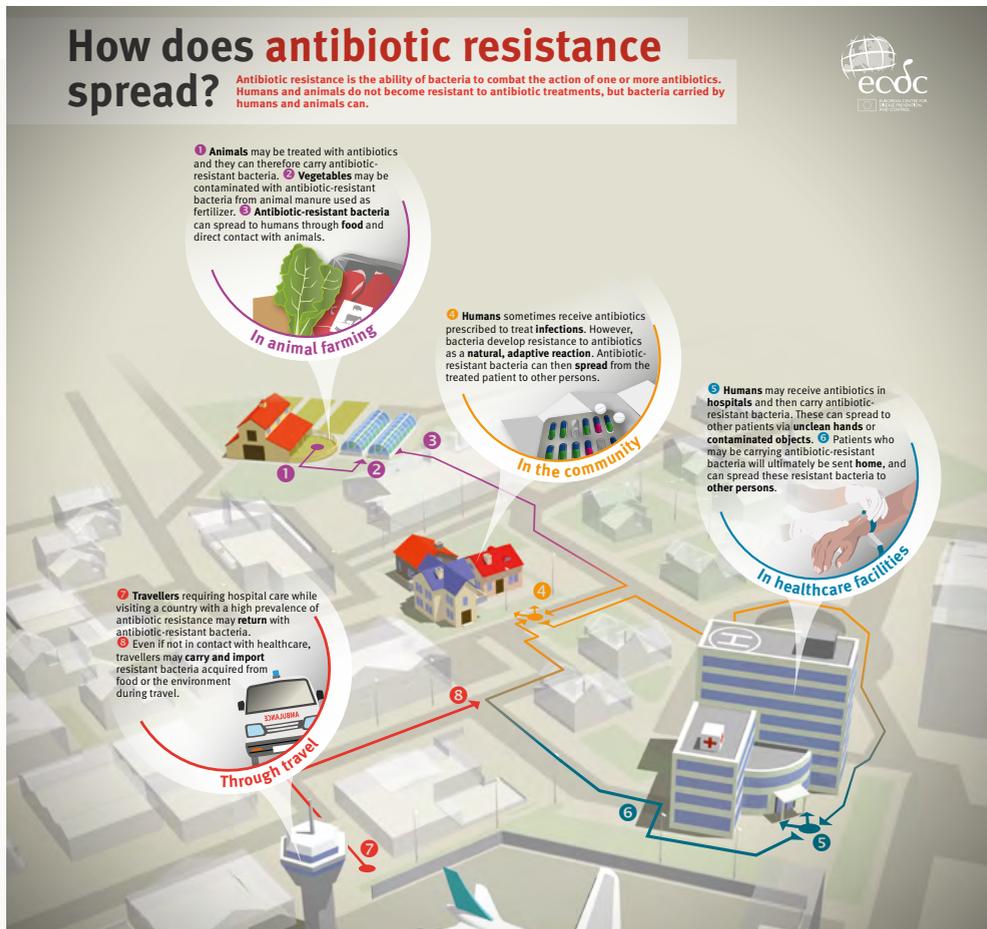
Premising that the use of veterinarian drugs is a prerequisite for animal welfare, their use must however be complementary to good barn management and adequate vaccination programs, which allow them to maintain a good state of animal health and minimise the conditions that favour the onset of diseases.

The theme of antibiotic-resistance is also at the centre of many **consumer information** campaigns on behalf of various gov-

ernments and the WHO itself, as well as the object of targeted institutional strategies to promote adequate protocols of antimicrobial drug use.

How many are used

At the moment there are no sources that give precise indications on the quantity of antibiotics administered every year in Europe. To do a preliminary analysis we can however resort to the data provided by the ESVAC project (European Surveil-



lance on Veterinary Antimicrobial Consumption), started in April 2010, with the aim of finding information from all over the European Union on the sale of antimicrobial drugs for animals.

In the Report are collected data related to the sale of antibiotics, the formulations of pharmaceutical products and medicated feed used in animal husbandry collected in 26 countries, including about 95% of the population of animals destined for food-production in the EU/EEA area. Before going into the analysis, however, it is opportune to make two premises. **The first is that the quantities of active ingredients sold do not match precisely the quantities actually administered to**

animals. The second concerns the management of drugs: while in Italy and in Spain the veterinarians who prescribe the drugs are not authorised to sell them, in other European countries this practice is allowed, but the vets are held responsible for excessive use and, if they do not properly inform the breeder, suffer penalties up to the revocation of the possibility of sale (this is the practice foreseen in the Netherlands, Denmark, United Kingdom, to give some examples).

In order to make data comparable between different member States, the values for amount of antimicrobials sold were normalised by a specific species index called PCU (Population Correction



Map of the total sales of all antimicrobials for food-producing animals, mg/PCu, for 26 countries in 2015.

Unit)⁴. The latest report presents data on sales in 2015, and includes a chapter on the changes in the use of drugs that occurred between 2010 and 2015. In 2015, there were sold as a whole 8.361 t of antimicrobial active ingredients for veterinary use in the 30 countries in question, generally showing a sales decline of about 5% compared to 2010.

Analysing the proportion between the antibiotics sold and the weight of national livestock assets (mg drug/PCU), one notices that the highest sales are recorded in Cyprus, followed by Spain and Italy. Our country, although appearing among the first member States for the sale of antibiotics, is the one in which the greatest reduction is recorded (equal to -24%) between 2010 and 2015, passing from 427 to 322 mg/PCU. This reduction in sales is the result of continuous information and awareness raising activities carried out by the health authorities and by producer representative associations to incentivise a responsible use of veterinary drugs. There are still technical difficulties in the comparison of data between countries, as the respective databases are still not aligned. An activity of standardisation is underway that should make comparison more reliable over the next few years, based on standard indicators.

How to reduce risks

The descriptions of practices and dangers are useful to understand what the correct methods for risk reduction are: the cardinal principle for the use of antibiotics, especially in human therapies, can be summarised “*using as little as possible, only when and how much is necessary*”⁵. The administration of antibiotics in animal husbandry, forbidden for preventive purposes, is always subject to veterinary prescription and, where possible, should

be based on an antibiogram carried out on the bacteria isolated from the animal object of the therapy: this exam allows to check the sensitivity of bacteria to specific antibiotics, thus leading to the identification of a more adequate therapy. In addition to practices related to an adequate use of drugs on farms, the control of **maximum residue limits (MRL)**, is crucial, which constitutes the maximum concentration of active ingredients in food legally acceptable **not to put human health at risk**. To ensure compliance with the MRLs, the law establishes a **period of suspension** of drug administration before slaughter or placing foods such as milk, eggs and meat on the market. The control of the presence of antibiotic drug residues in food is entrusted to the National Residual Plan, which will be discussed in more detail in the paragraph on controls and information for consumers.

The Ministry of Health, which is responsible for monitoring, together with the Regions and the competent local health authorities, and supervising the administration of antibiotics to farm animals, has published **guidelines for the correct use of antimicrobial drugs**, in collaboration with the Italian Breeders Association (IBA), Federchimica, Assalzoo and the Italian National Federation Veterinary Order (INFVO).

The document introduces also the importance of **biosafety**, understood as all those devices useful to avoid the introduction of pathogen micro-organisms into farms (such as attention during the purchase of animals, respect of the rules of hygiene, control of supplies, etc.). The use of vaccination programs and the interaction between veterinarians and breeders are promoted, with the preparation of solid health programs and constant communication between the two parts.

HOW ARE THE MAXIMUM RESIDUE LIMITS ESTABLISHED?

The definition of the maximum residue limits is the result of a process based on 4 successive stages:

1 For each substance, the values of NOEL (No Observed Effect Level) are calculated through laboratory tests, the maximum quantity of a given active ingredient which does not give rise to biological effects when administered in the diet to laboratory animals sensitive to that substance.

2 Starting from the NOEL value the Acceptable Daily Intake (ADI), i.e. the amount of the substance that can be taken through-

out the animal's life without the appearance of effects, is established.

3 On the basis of the ADI for animals, one calculates the ADI for humans, that is the amount of a substance that can be taken daily for life by a person without the appearance of any effects. The human ADI is obtained by dividing the animal ADI by a safety factor that varies from 100 to 100,000: in practice it is assumed that the man is at

least 10 times more sensitive than the animal species on which the analysis was conducted, and that in the same human species sensitivity can vary up to 10 times.

4 Finally, on the basis of the human ADI and assuming that an individual eats for his whole life exclusively a particular food, the MRL is calculated for that specific substance in that particular food.

EU GUIDELINES ON THE PRUDENT USE OF ANTIBIOTICS

In September 2015, the European Commission published a Communication relative to the Guidelines on the prudent use of antimicrobials in veterinary medicine. These guidelines, which are non-binding, are intended to define the principles for their prudent use in order to

combat antibiotic resistance, indicating the measures that member States must consider when developing and implementing national strategies. To turn the guidelines into practice, the document was accompanied by a series of practical examples of their use in the various mem-

ber States for the implementation of each ingredient.

The Commission highlights the fact that any use of antimicrobials (both in human and veterinary medicine) may result in the development of antibiotic resistance phenomena. The risk increases if antibiotics are

used improperly, for example in a non-targeted way (collective preventive treatments or using on non-susceptible organisms), at doses below-therapeutic levels, repeatedly or for inadequate time periods.

The guidelines provide some general indications, and others more specific depending on the various animals. In general, the goal of a prudent administration is to reduce to a minimum the use of antimicrobials, delineating the use in cases of real necessity. In such situations, the prescription and administration of these

medicines must be justified by an animal's diagnosis by the veterinarian, and possibly supported by specific tests to determine the most appropriate choice of the antimicrobials. Prophylaxis should not be taken in a systematic way, but must be reserved for specific indications in exceptional cases. Where possible, an individual treatment of infected animals should be preferred (for example, by administering injections) to collective or group treatments.

The narrow-spectrum antimicrobials are, in general, to be preferred to those with

a broad spectrum. If an animal or group of animals suffer from recurrent infections that require antimicrobial treatment, one needs to take action to eradicate the strains of microorganisms, establishing why the disease is recurrent and changing the conditions of production, animal husbandry and/or management.

Finally, the use of antimicrobial agents that tend to favour the propagation of transmissible resistance should be avoided.

PARTICIPANTS IN THE CHAIN OF CONTROL

The Ministry of Health is responsible for collecting the sales figures of veterinary medicinal products from those responsible for their commerce (AIC).

The Livestock institutions are involved in monitoring resistance to antibiotics on farms, even offering diagnosis on diseases and zoonosis⁶.

The ASL, within their institutional competencies, constantly monitor compliance with the provisions concern-

ing the prescription of veterinary medicinal products, place the controls provided by the relevant regional medicine surveillance plans and perform inspections of final operators to monitor the records of shipping, delivery and of the stocks.

Finally, in all the Member States of the EU the companies must compulsorily keep for at least five years - regardless of whether the animal is still in the farm or not

- the records of all medicines used in animals intended for food production, including the treatments with antibiotics.

The records are used to verify the use of antimicrobials in the farm, to observe trends and analyse changes.

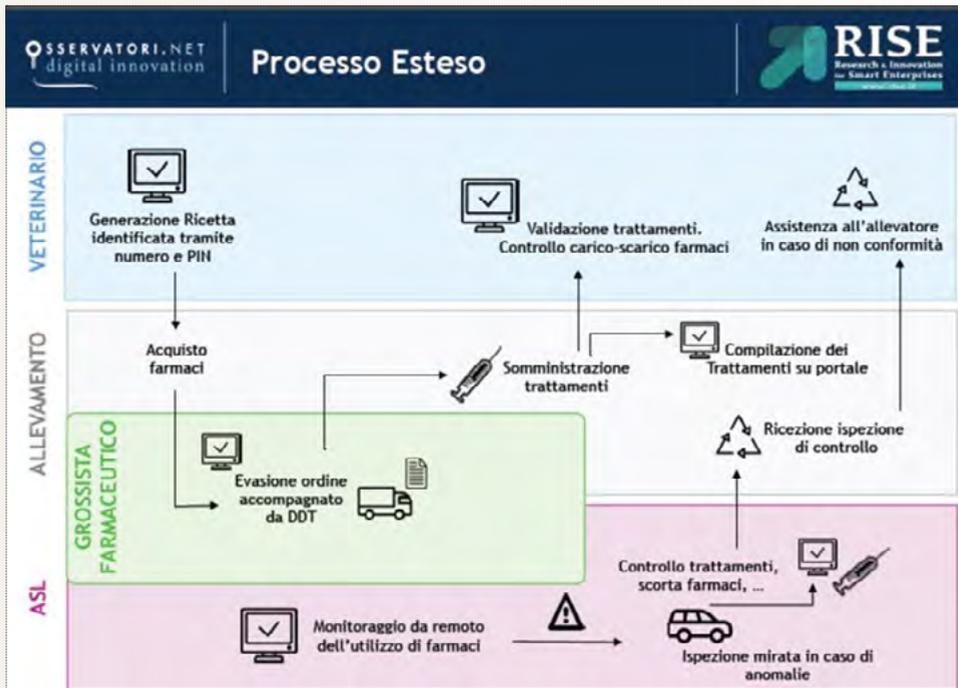
THE ELECTRONIC VETERINARY PRESCRIPTION MANDATORY

The new **electronic veterinary prescription** (European law November 20th, 2017, n. 167 implemented by the Law Decree 25th July 2018, n. 91) will be mandatory from 1st January 2019 and will apply to the whole cycle of management of medicines and medicated feed/products intermediates intended for use in veterinary medicine, from

prescription to supply up to the registration of information of the treatments carried out, without introducing new additional obligations or rules respect to the current legislative norms. It will involve the veterinarians, pharmacies and para-pharmacies, authorised direct sales wholesalers, feed mills, veterinary services of the

Regions/local health authorities, the owners and/or keepers of animals for food production and the owners and/or holders of pets.

The General Directorate of animal health and pharmacy veterinarians, in collaboration with the Livestock Institute of Abruzzo and Molise, has created the computer-



Phases and actors involved in the process of issuing the electronic prescription

Source: <https://vc/informazioni.html>

ised system for the electronic veterinary prescription, already experimented in different Regions. Maximising traceability and transparency, the prescription of veterinarian medicines with an electronic format will favour the correct use of veterinary medicines and will detect real consumption, increasing, as a consequence, the protection of public health. At the same time the digital document will make the pharmaceutical surveillance activity and health care risk analysis more efficient in addition to reducing the margin of error in its com-

pilation. The electronic prescription, connected with the National Database will allow a considerable simplification of procedures with the possibility of inserting also vaccinations and eliminating the paper records of farm treatments. Finally, the digital prescription will reduce the obligations and costs, not just for the public administration, but also for the citizen owner of pets and for the breeder. Eliminated the obligation of resorting to the paper version, it will be much smoother for anyone to proceed when buying veterinary medicines providing your own pharmacist only with a VAT number and the four-digit PIN code generated by the computerised system at the time of the prescription insertion by the vet.

Amongst the strengths, the full sharing of data with all the players in the medicinal veterinary supply chain (medicinal veterinarians, pharmacists, distributors, farmers), the simplification and the reduction of the procedures and obligations, the containment of the resulting costs imposed also by penalties for formal errors, the improvement of control activities and reprocessing of data useful for contrast of antimicrobial-resistance.

Ricetta Veterinaria Elettronica

(Decreto Legge 20172 n. 167 del 23 novembre 2017)

OBBLIGATORIA



- ▶ Sostituisce la forma cartacea della ricetta sull'intero territorio nazionale
- ▶ Semplifica le procedure e riduce gli obblighi amministrativi

PERCHÉ?

CHI?

- ▶ **AUMENTA** la tutela della salute pubblica
- ▶ **FAVORISCE** l'uso corretto dei medicinali veterinari
- ▶ **RILEVA** il consumo reale dei medicinali veterinari
- ▶ **RAFFORZA** la lotta all'antimicrobico-resistenza
- ▶ **MIGLIORA** il sistema di tracciabilità dei medicinali veterinari
- ▶ **RIDUCE** gli adempimenti e i costi
- ▶ **RENDE** più efficiente l'attività di farmacovigilanza e di analisi del rischio sanitario
- ▶ **IL MEDICO VETERINARIO** deve essere al centro della gestione del medicinale veterinario



- ▶ Medici veterinari
- ▶ Farmacie e parafarmacie
- ▶ Grossisti (autorizzati alla vendita diretta)
- ▶ Mangimifici
- ▶ Servizi Veterinari delle Regioni/ASL
- ▶ Proprietari e/o detentori di animali da produzione di alimenti
- ▶ Proprietari e/o detentori di animali da compagnia

COME?

- ▶ www.vetinfo.sanita.it
SITO OPERATIVO DELLA RICETTA VETERINARIA ELETTRONICA; ACCESSO IN BASE AL PROPRIO PROFILO UTENTE CON LE CREDENZIALI
- ▶ www.ricettaveterinariaelettronica.it
SITO INFORMATIVO SULLA NUOVA RICETTA VETERINARIA ELETTRONICA



Extract of the information brochure on the new electronic veterinary prescription.

Source: Ministry of Health

THE NATIONAL PLAN FOR THE RESPONSIBLE USE OF VETERINARY MEDICINE AND THE FIGHT AGAINST ANTIBIOTIC RESISTANCE IN POULTRY FARMING

*UNAITALIA, the association of reference for operators in the poultry sector, initiated along with the Italian Society of Avian Pathology, a **voluntary plan** aimed at promoting responsible use of antibiotics in poultry farming. The Plan was promoted by the Ministry of Health, which evaluated beforehand its contents, using a group of experts who will also examine the results.*

Specifically, the program aims at reducing the total consumption of antibiotics by 15% in 2015 and by 40% by 2018 compared to 2011. The results have been

fully received, so much so that 2017 has registered a -63% (data certified by a third body, starting from 2015). The Plan introduced, in addition to the ban on cephalosporin of 3rd and 4th generation, from May 2017, the banning of colistin in chickens. In general, a particular regard is reserved for more problematic antibiotics like fluoroquinolones and macrolides. Monitoring is planned for antibiotic resistance both in breeding and at the slaughterhouse. The strategy is based on the one hand on the promotion of prevention protocols, on

the other the continuous updated training of operators. The operational aspects of the reduction scheme are divided into several stages, which include the promotion of best animal husbandry practices, the development of complementary and/or alternative systems that enable the reduction of operations with antimicrobials, the constant monitoring of actual consumption, the exchange of information between operators and their training. The next step will be adherence to the Classyfarm system.

PREVENTION IS BETTER THAN CURING: THE “SUSTAINABLE BARN” PROJECT OF THE LIVESTOCK INSTITUTE OF TURIN

Design a barn to ensure the welfare and health of animals, while respecting the environment: this was the goal that brought the PolYTECHNIC of Turin and the Piedmont Livestock Institute to realise the model of “Sus-

tainable Barn”. The project is a collaboration of architects, farmers, veterinarians and agronomists who have combined their expertise in order to identify a structure for cattle that would reconcile the functional charac-

teristics with environmental sustainability, health care and wellness criteria and its insertion into the local agronomic reality. The design stems from the need to find more efficient solutions to make sustainable modern

farming practices, while reducing the stress factors and poor welfare. The project has permitted the creation of an interactive and virtual mock-up model of a sustainable cattle barn.

Among the various aspects considered in the project, the reduced use of veterinary drugs stands out, thanks to

a preventive approach towards animal diseases. The ventilation system has been studied in order to ensure the maintenance of an adequate and constant microclimate inside the barn, through the control of movement, temperature, air humidity and gas concentrations produced by the litter: these attentions permit the alleviating of res-

piratory diseases in animals, and consequently lower the share of administered antibiotics. Even the flooring and the litter are specially chosen so as to reduce the risk of foot injuries, with consequent reduction of the administration of anti-inflammatory drugs. (www.izsto.it)

WHY CURED MEATS CONTAIN SALT

The practice of adding substances to foods for easy storage is not a chemical or industrial invention, but is an **ancient tradition**. Some examples are the addition of an acid juice (such as lemon) to prevent the blackening of a vegetable, as well as the use of smoke from wood, especially ones rich in resin. In the specific case of meat, the use of salt. In fact, the ancient Romans already had observed that saltpetre was improving the production of cured meats and sausages, avoiding the browning of the meat and especially preventing the proliferation of unwanted bacteria. Precisely for this reason, in the production of **some cured meats** are added, in controlled quantities, nitrates and nitrites that,

inter alia, have the property of maintaining the colour of meat. In 2003, the EFSA – European Food Safety Authority explicitly stated in an important counsel to the European Commission that “in most processed meat products the addition of nitrite (or nitrate) is **necessary** to prevent the development and production of toxins for *C. botulinum*”.⁸ Also EFSA has confirmed that the level of consumer exposure to foods with added nitrite and nitrate is adequate and does not constitute a danger, if these are consumed with equilibrium⁹. Thanks to the use of the refrigerator and microbiological knowledge, in addition to compliance with hygienic rules and to the exploitation of the bacte-

riostatic properties of spices and herbs, you can nowadays produce safe cured meat using **few preservatives**. In the PDO hams, for example, the **prolonged maturing process** makes unnecessary the use of nitrites, which in fact are no longer used in these products. As for all substances, also in the case of these compounds an **excessive consumption** can lead to negative consequences for health. Although it should be noted that nitrates are a component of many plant foods, the **nutritional balance**, repeatedly emphasised with the promotion of the Mediterranean Diet, is the way to valorise the benefits of each individual food reducing health risks.

1.2 Microbiological and chemical contaminants

A possible threat to consumer safety regards the possible contamination with microorganisms or chemical substances, which may come into contact with food (or with the raw materials such as animal feed) in the many stages of the process. In truth, these types of contamination are not specific to meat, but all fresh food. For this reason, it is essential to have a good management of all distribution phases that occur from the exit of manufacturing sites onwards, including domestic conservation. One risky practice is the poor upkeep of household refrigerators which, if not perfectly clean and not kept at appropriate temperatures, can be a source of contamination.

Microbiological contamination

Microbiological contamination is by far the most frequent cause of food alert. In this category belong contaminations by bacteria (such as *Salmonella*), parasites (*Trichinella*), viruses and fungi. European legislation has intervened to safeguard consumer safety with Regulation (EC) No. 2073/2005⁷, which establishes the microbiological criteria applicable to many foods, including all types of meat. It is the basis of the microbiological tests conducted by both official controls and by self-control: in fact, it not only obliges food operators to ensure that food complies with the safety and processing hygiene criteria, but also establishes that the authorities will monitor compliance, also through sampling and food analysis in the context of the supervision activities. The goal of self-control of quality management systems and systems developed by the agribusiness companies is that of minimising the risk of microbiological

contamination through widespread control of the processes and, in particular, of preservative systems. Even if not included in the 2073, among the microbiological risks are also mycotoxins, toxins produced by certain fungi or moulds in plant foods such as peanuts, walnuts or hazelnuts, corn, grain or soybeans that can enter the food chain through meat or other animal products such as eggs, milk and cheese from cattle that have consumed contaminated feed. In addition to the controls implemented throughout the supply chain, consumer behaviour plays a key role: the best domestic conservation practices and proper cooking of food are fundamental to reduce risks.

Chemical contamination

The chemical contaminants include chemicals in the environment such as pesticides, heavy metals, and other debris that may accidentally enter the food chain during the food production process. Chemicals such as pesticides or medicines used for animal health are subject to strict regulations, and must pass strict toxicity tests for humans and the environment, before being admitted to registration with the European or National Authorities. Also for industrial substances, such as dioxins and heavy metals, there are strict controls, designed to avoid contamination of the environment and to ensure the protection of public health.

2 CONTROLS AND INFORMATION FOR CONSUMERS

The quality and safety of food depends on the efforts of all people involved in the agricultural sector: farming, processing, distribution, storage and even in the consumer phase. In a nutshell, food safety is a shared responsibility from farm to fork.

To ensure the quality and safety of food throughout the chain, it takes, on the one side, operating procedures to ensure the healthiness of foods, and on the other, monitoring systems to ensure that operations are carried out correctly. The road to security passes through two obligatory stages: the attribution to the production world of the responsibility of safe food production and the execution of appropriate official controls carried out in an effective and coordinated manner among the different competent authorities.

2.1 Traceability and tracking

Often the two terms are used interchangeably, but they are not exactly synonymous, although they represent two sides of the same coin:

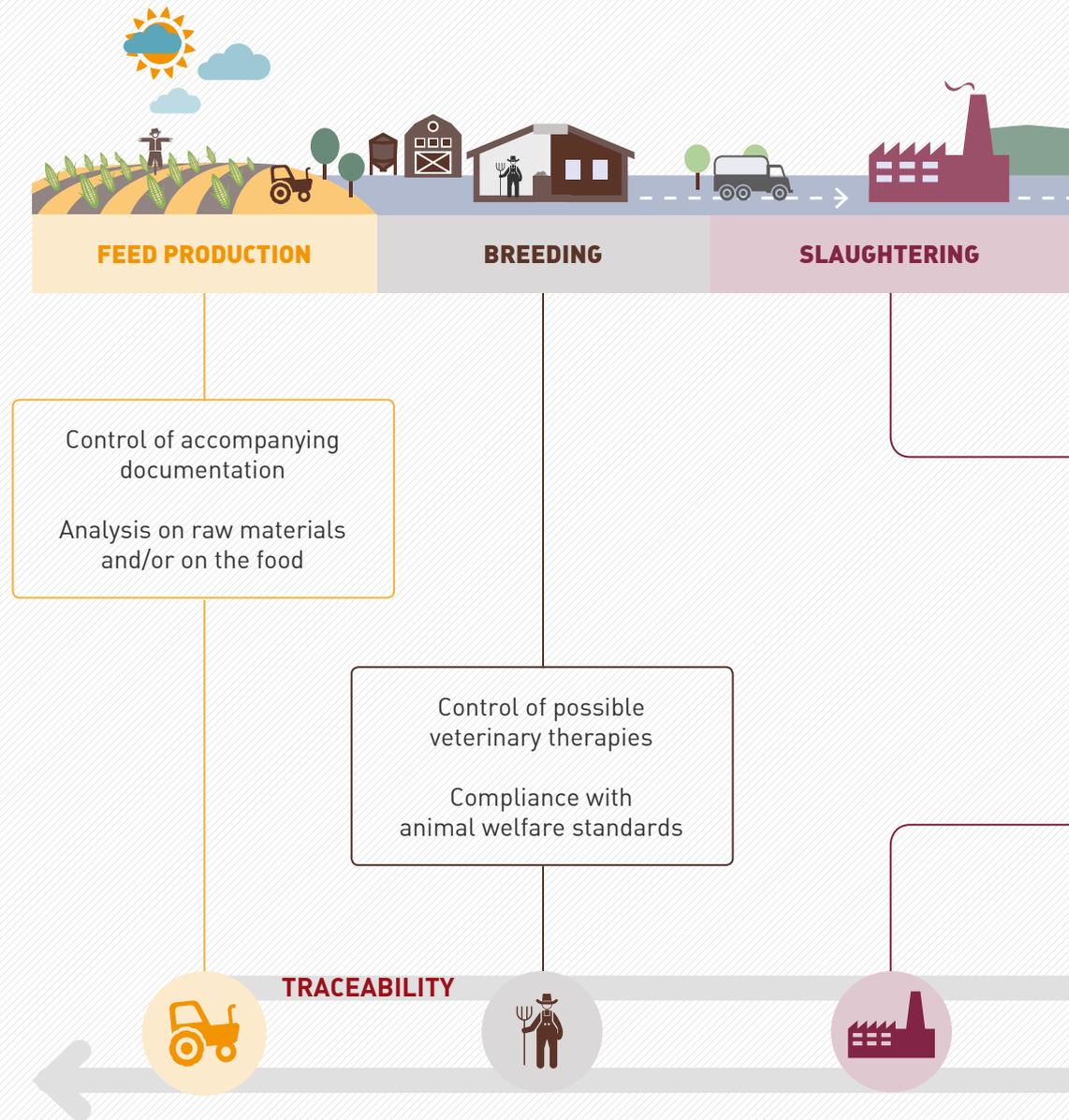
- **Traceability** means the ability to describe the path of a raw material or a quantity of production through the passageways from one business entity to another, within the production chain: from production, to processing, up to distribution. In essence, the flow of goods is accompanied by a flow of information, which are adequately recorded and retained at each step.
- **Tracking**, however, implies the possibility to reconstruct backwards the entire path of a product, from its final state to the starting raw materials.

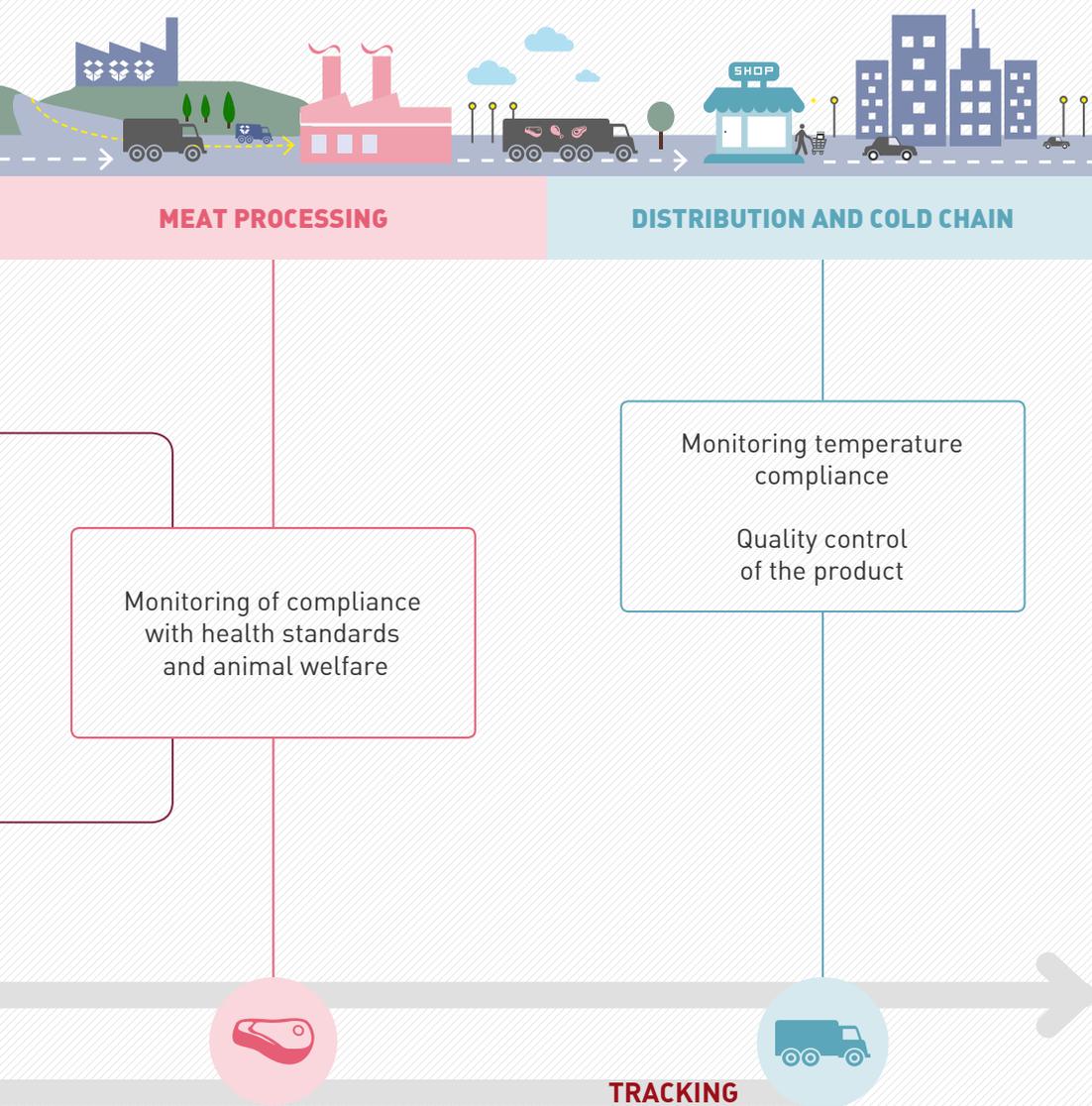
These approaches are essential elements in the management of food security, because they allow the reconstruction of the characteristics and history of a food along the production chain, as well as ensuring a timely withdrawal from the market, when issues appear related to the quality or safety that pose a risk to the consumer. Since 2005, the legislation requires that all food products are properly tracked, involving in this process all the players in the food chain. The obligation of traceability also applies to products of foreign origin (in whole or in part), and permits finding the origins of the raw materials.

In addition to being a fundamental prerequisite for the management of safety and food emergencies, traceability has an important role ensuring the quality of the product: by a careful system of documentation, in fact, all the checks carried out on processes and products can be traced in every production stage.

TRACEABILITY AND TRACKING OF MEATS

MAIN CHECKS PERFORMED





2.2 Institutional controls

In Italy, the protection of food security is entrusted mainly **official control** activities carried out by the **Ministry of Health**, in compliance with the food safety model introduced in the European Union by Regulation 178/2002¹⁰, Regulation no. 882/2004¹¹ and subsequent regulations of the so-called “Hygiene Package”¹².

The Ministry operates at central level, with the General Directorate for hygiene and food safety and nutrition and, at regional level, with its Regional Offices. To these are added the controls of the Regions and Autonomous Provinces of Trento and Bolzano, through their territorial structures, Departments of Prevention of Local Health and public Laboratories of Official Control, such as the Livestock Institutes. The controls are designed to ensure that food and feed on the market comply with the regulations aimed at protecting **consumer’s health, animal welfare** and prevent **food fraud**. In the first two cases one intervenes to ensure the safety of the consumer, avoiding contamination and preventing situations that could lead to the development of bacterial contamination.

In the case of commercial fraud, however, controls verify the conformity of the product with the characteristics declared by the manufacturer about the amount or source, and determine any tampering that could cause danger to human health¹³. In both cases, non-compliant or products considered dangerous are blocked before their arrival on the market, or withdrawn from the market.

The controls, which take place throughout the supply chain, cover both Italian or foreign products to be marketed domes-

tically and Italian products destined for export. In general, the surveys provide a fully investigated product through inspections, sampling and laboratory analysis, or inspections of production processes with controls that may include also the staff assigned to the processing.

As for the meat sector, the controls are focused on farms, with regard to health and animal welfare, as well as slaughterhouses in the processing industries. Continuing along the chain of distribution, attention is drawn to the rules for labeling and compliance with consumer information requirements.

According to regulatory provisions, the controls are programmed on the basis of a risk assessment: the major resources are dedicated to those sectors which involve greater risks for consumer’s health. Apart from this, the various competent authorities should operate in an integrated and coordinated manner in order to allow effective actions and reducing to the least the inefficiencies due to any duplications.

Complementing the official controls provided by the legislation, businesses in the food industries have to implement self-control plans in accordance with the principles of HACCP (Hazard Analysis Critical Control Points), which provide for the identification of their critical points and prepare, on them, monitoring and improvement plans.

EUROPEAN AND ITALIAN RULES ON FOOD SAFETY

“Security from the farm to the fork”. This is the principle of the strategy adopted by European Union countries for safeguarding health and consumer safety. In practice this means preparing a system of integrated control between the various subjects involved to guarantee compliance with the requirements of food products and for the welfare of animals and plants, whether they are produced within the EU or imported.

The general principles on which the legislation concerns are¹⁴:

- *integrated controls through-*

out the food chain;

- *interventions based on the Analysis of Risk;*
- *primary responsibility of the industry for each product created, processed, imported, marketed or administered;*
- *traceability of products throughout the supply chain;*
- *consumer as an active part of food security.*

In addition, to ensure a scientific approach to issues related to food, the European Authority for Food Safety was established (EFSA¹⁵) in 2012, which, in collaboration with

national authorities and in consultation with stakeholders, since then provides independent scientific advice and clear communication on existing and emerging risks. EFSA elaborates scientific and expert advice to provide a solid foundation for legislative work and to facilitate timely and effective decisions in risk management.

Especially for meat, the legislation is very detailed, both in the definition of the requirements of the production facilities and for product specifications and related control systems.



IS IMPORTED MEAT LESS SAFE THAN ITALIAN MEAT?

If we were to draw up a list of topics that generate most concern for consumers in relation to food security, the origin of the meat they eat would certainly appear up at the top. It is in fact a quite widespread belief that imported meat is “less safe” than homemade, a hypothesis which in reality is not confirmed by the facts.

Within the EU, the control system is harmonised by Community law and follows the principle of safety “from farm to fork”: this means that the cattle are traced at every stage of the supply chain, regardless of the country in which it is bred, and cannot be treated with substances prohibited by the Union (such as, for example,

anabolic hormones).

Meat coming from other member States, therefore must meet the same requirements as in Italy, and thanks to the obligation of traceability, information can be traced back at any time to specific phases of the supply chain.

As for the non-EU countries, however, the question becomes more complex. In some countries, in fact, the national legislation does not impose the obligation of traceability along the supply chain, giving priority to analytical controls on the product to be placed on the market, rather than supervising pre-slaughter. This does not mean that the products are less safe or controlled, be-

cause to obtain the importation authorisation in Europe, the companies must comply with the same requirements in force in the EU market.

Either way, in Italy there are various control points located in places of commercial trade, borders or at ports and airports: the so-called PIF (Border Inspection Posts) where the controls on food imported from other countries and the UVAC (Veterinary Offices for Community Compliance) involved in trade between member States are placed. P.I.F. are directly connected to the European food alert system: this allows, in the presence of a non-compliant product, to take swift action to prevent the placing on the Community market or eventually its removal.

The agro-mafias insert food into the market without the necessary checks and for this reason they must be prosecuted. The supply chains of meats, instead, spend resources to guarantee to consumers that the product, national or foreign, have the requirements of reliability demanded by the market.



NRP AND CONTROLS FOR THE DETECTION OF PROHIBITED SUBSTANCES

EU and national legislation lays down control measures for the presence of undesirable substances in food. In particular, each Member State must annually perform the National Plan for the detection of Residues (NRP), a structured program which aims at overseeing and monitoring the presence of residues of substances for livestock use, both illicit and authorised, and environmental contaminants in live animals and the feed from which they originate. The NRP consists in a series of samples prepared at national level adapted to the regional situation and carried out by the National Health Service, both on farms (primary production) and in the establishment of initial processing (slaughterhouses or the milk collection centres).

The analyses to reveal the presence of illegal substances are carried out by the laboratories of the Livestock institutes.

- **Category A:** includes unauthorised substances for the treatment of farm animals. For example growth hormones.
- **Category B:** includes the veterinary medicinal prod-

ucts, for which the EU defines a maximum residue limit that cannot be exceeded in consumer products; and environmental contaminants such as heavy metals.

In the event that the administration of prohibited substances is detected, or the content of residues of authorised substances or environmental contaminants were higher than the established limits, the application of sanctions would be implemented to protect the consumer such as the recall of dangerous products, the application of administrative and criminal sanctions, the conducting of epidemiological investigations to determine responsibilities and uncover any further treatments. For some substances, such as growth promoters, the NRP also adds other specific controls. The use of low concentrations means that the residues of these substances present in animal tissues are difficult to reveal by laboratory analysis. In this case, we resort to specific histological examination, i.e. tissue analysis, carried out directly on the carcass after slaughter operations:

the use of growth promoters, in addition to increased enhancement of the animal, in fact also determines the alteration of some organs (sex glands, gonads, thymus etc.) whose analysis can highlight situations that deviate from the norm and, accordingly, permits the use of illicit substances to be suspected.

THE RESULTS OF THE NRP 2017

In 2017, the implementation of the NRP has led to the analysis of **44,108** samples, of which 15,919 for the detection of residues of substances in Category A (equal to 36% of total analysis) and 28,198 for the detection of residues of substances in category B (equal to 64%). The samples that have provided irregular results for the presence of residues were a total of 39, equal to 0.09% of the total of the samples analysed. Of these, 2 were found not to conform due to the presence of residues belonging to category A and 37 due to the detection of residues of substances in Category B.

2.3 The self-control system of companies

According to European regulations¹⁶, any activity that operates in the food industry has an obligation to prepare a plan of self-control according to the HACCP (Hazard Analysis and Critical Control Points). This method provides that each operator performs an analysis of potential risk factors for health resulting from its operations, and define one or more measures for the control and prevention of the risks. The HACCP Manual must be validated by the Health Authority (ASL) which oversees its implementation.

The HACCP self-control plan is based on seven principles:

1. Identify any hazard to be prevented, eliminated or reduced.
2. Identify the critical control points (CCP – Critical Control Points) in the phases in which it is possible to prevent, eliminate or reduce a risk.
3. Establish, for these critical control points, critical limits which separate acceptability from unacceptability.
4. Establish and implement effective monitoring procedures at critical control points.
5. Establish corrective actions if a critical control point is not under verification (exceeding the established critical limits).
6. Establish the procedures to be regularly applied to verify the effective functioning of the measures taken.
7. Prepare documents and records commensurate with the nature and size of the food business.

The plan must be applied and finalised at preventing problems and must provide for appropriate corrective actions to minimise risks every time there is a non-compliance. The plan includes general and specific measures. Those “**general**” are represented by common rules that apply to all processing areas and are inher-

INFORMING THE CONSUMER WITH THE PRODUCT LABELS

manufacturer to provide information to the consumer about the product they are about to purchase.

The labelling of meat, which has become mandatory the last 10 years, even though at different times for different products, is a system that requires the manufacturer

At European level, the matter is currently governed by Regulation 1169/2011, which establishes common rules for the labelling of the various species and serves as a coordination between the various sectors, ensuring consistency of the information contained in the different labelling systems.

Although there are subtle differences between the various species, in general the information concerns the country of breeding, slaughtering and, if applicable, processing of the product. This information can help the conscious choice of consumers during the purchase.



ent to the hygiene of operators, premises, equipment, processes and products, as well as the application of verification measures of the rules.

Those “**specific**”, defined for each type of production process, aiming at the identification, evaluation and control of the specific risks of a biological, chemical and physical nature which could affect the safety of food products.

The dangers are evaluated according to the principles outlined in the “Codex Alimentarius” and the national and international legislation¹⁷.

2.4 A purely Italian safety: supply chain and the protection consortium

The Italian food system presents some peculiarities that, in addition to determining a strength in terms of quality and value, permits excellent safety levels to be guaranteed.

A first aspect concerns the presence of effective and well-coordinated **supply chains**. A product is made “in the food chain” when all the players involved in the production process are integrated and coordinated with each other: in this way an additional control, direct and complete, of agricultural and industrial production systems is possible on behalf of those who have product liabilities towards the market.

The purpose of the chain is to make transparent the relationship between the subjects involved in the production and processing of the final product, by developing a relationship of trust, with shared objectives between the parties involved. An added value to the chain is to minimise risk by simplifying the control plans. Products relating to controlled supply chains allow a better understanding of quality and food safety data, generally more detailed than the minimum requirements of the law, better control

PDO & PGI IN ITALY

Italy holds the European record for the number of PDO and PGI awards, with more than **261 quality products** recognised¹⁸. Due to the international importance of these designations, the awarded products are subject to strict and specific controls, in addition to the routine checks laid down by European and national legislation. In our country, the PDO and PGI products of the pig production chain are subject, as well as inspections of the national health system, to the annual inspections at farms, slaughterhouses, processing plants, ham and cured meats companies, carried out by two independent institutions designated by the Ministry of Agriculture, Food and Forestry.

These organisations certify the quality of raw materials and in particular compliance with the rules of production materials: a system which guarantees the acquisition of high quality products, made according to traditional recipes.

About a third of European PDO and PGI meat based products are Italian. In addition, the first 4 PDO Italian products for export volumes and market share belong to livestock chains: Parma ham, San Daniele ham, Grana Padano and Parmigiano Reggiano cheese.



of product standards with respect to the expectations of the consumer and greater recognition through dedicated brands. In Italy it is estimated that about half the beef and the pork are produced in the supply chain, while for poultry meat in the production chain is almost complete.

A second aspect concerns the presence of numerous products identified internationally as gastronomic excellences such as those protected by the geographical indication trademarks.

The European Union protects the typicality of some food products through the recognition of **PDO (Protected Designation of Origin)** and **PGI (Protected Geographical Indications)**. These designations, recognised throughout Europe, are awarded only to those high quality products whose

production takes place in defined geographical area, and for which there is a causal link between the geographical area and the quality or characteristics of the product and the characterising aspects of the production process¹⁹.

In other words, the product should show a strong link to the territory, to whose name must be traced certain characteristics of the product itself. The function of these trademarks is threefold: to protect quality products from misuse and imitation; give consumers reliable information about the products they purchase; contribute to the protection of rural areas, whose socio-economic system often depends on the development of typical agricultural food production and quality.

VOLUNTARY LABELLING IN THE POULTRY SECTOR

Italian legislation foresees the possibility, for operators who wish to do so, to provide voluntary and additional information on the label other than that required by law.

To achieve this, however, a particular set of voluntary labelling procedures must be followed, which are recognised by the Ministry of Agriculture: in the poultry sector, the first and most comprehensive is the one developed by UNAITALIA, representative of 99.98% of the producers who use voluntary labelling.

In addition to the information prescribed by the law, the guidelines state that you can enter specific information relative to:

- the food: for example, no GMO, free of animal flour and/or added animal fat, vegetable food etc.),
- the kind of farming adopted: raised on the ground, outdoor, extensive covering, etc.,
- the genetic type,
- animal welfare measures: more space in breeding areas respect to the legal limits, the presence of natural light in infrastructure dedicated to breeding, presence of straw bales or perches to encourage natural behaviour, and recently the reduced use of antibiotics.



3 THE COMMUNITY FOOD ALERT SYSTEM

To notify risks (real or potential) in real time for the health of consumers, a system of Community rapid alert (RASFF) was established, which, through a network of spreading information, permits a rapid and coordinated action. In practice, the RASFF constitutes a network of “contact points”, identified in the European Commission, in the EFSA (European Food Safety Authority), the ESA (Supervisory Authority of the European Free Trade Association) and at national level, identified by the authorities in individual member Countries.

All parties involved exchange information in a clear and structured way by means of protocols that ensure the homogeneity of the reports: the Ministry of Health is the Italian point of contact. In case of serious and immediate risk (for example, of a toxin such as botulinum), further to providing immediate seizure of the products, the emergency procedure can be supplemented with press releases to inform the public on the risks linked to the consumption of a particular product and the mode of delivery of the food to the competent local Health Authority.

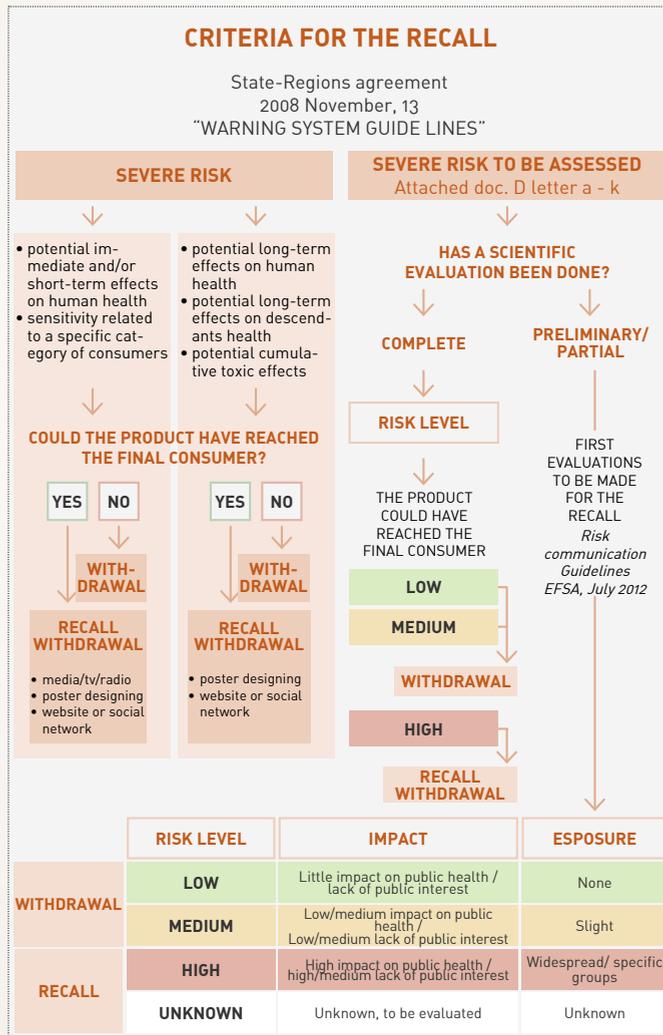
3.1 Different levels of alert: when is it right to worry?

The Alert System foresees **four types** of communications that are sent to the member States depending on the severity of the situation:

- The **Alert Communications**: are sent when food or feed which present a serious risk are on the market and where action is needed quickly for their withdrawal or recall. The RASFF member that identifies the problem and takes proper action (e.g. product recall) starts the alert with the objective of giving all members the information to verify whether the product in question is on their markets, so that they can take the necessary measures.
- **Informational Communications**: are used when a risk is identified in respect of a food or feed on the market, but other Member States are not required to take rapid action. This is because the product has not arrived or is no longer present on their market or because the nature of the risk simply does not require such action.
- The **rejections at the border**: concern consignments of food and feed undergoing an exam and rejected outside the EU borders (and the EEA, the European Economic Area) when a health risk is detected. Notifications are sent to all EEA border posts.
- The **News**: all information feed that have not been sent as a warning, but which also contain useful news for the safety of consumers.

NOTIFICATIONS TO CONSUMERS

Consumers are explicitly warned (with direct and multi-channel communications) if a dangerous product, which has already been sold to consumers through the distribution network, is to be recalled from the market.



Source: Ministerial note - Procedures for the recall by OSA of non-compliant products
www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2016&codLeg=54999&parte=1%20&serie=

3.2 What are the risks that generate alerts?

Each year the results of the notifications to the RASFF system are collected in a report published by the European Commission and then translated by the various Member States. The annual report represents an extremely useful tool for getting immediate information on which food categories were most subjected to criticism

during the course of the year, as well as the type of risk detected.

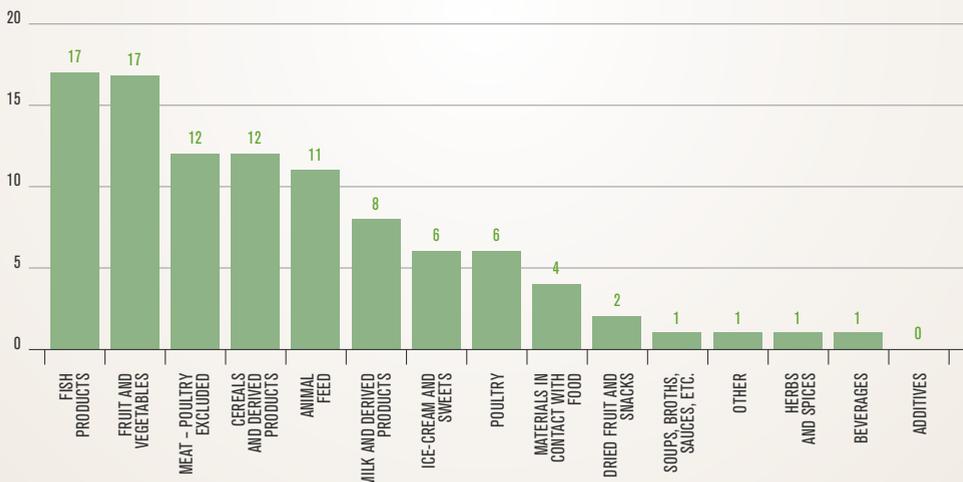
From the analysis of the report dated 2016²³, it emerges that notifications are gradually decreasing, while most warnings concerned the contamination by microbiological pathogens such as Salmonella and Escherichia coli (total 782 notifications in 2014), and the presence of residues of pesticides (435), mycotoxins (383) and heavy metals (285).

NOTIFICATIONS IN ITALY

Overall, in 2016 there were **2,925** notifications²⁰, compared to 2,967 the previous year. The comparison with previous years reveals a decrease in alerts: in 2012 received notifications were 3,436, and 3,721 in 2011. The country most subject to notifications turns out to be Turkey (276), followed by China and India.

Looking at the situation in our country, Italy has proven to be the **first member state for the number of notifications sent** to the European Commission, thereby demonstrating intense and thorough monitoring activities throughout the country, with a total of 415 notifications (equal to 14.2%), while in 2015 the notifications issued by Italy were 511 (17.2%).

Italy is the thirteenth in the ranking for the number of notifications received, with a total of 105 national products reported as irregular (compared with 155 notifications in 2015). The type of irregular products are heterogeneous: the highest number of notifications concerned fishery products, followed by animal and dairy products.



4 ANIMAL WELFARE

4.1 The foundations of animal welfare: five freedoms

The interest for animal welfare, as we understand it today, can be traced to **1965**, the year the **Brambell report** was published, the first scientific paper on the subject commissioned directly by the British government. The document is specifically related to farm animals and sets out the “**five freedoms**” to be protected to ensure animal well-being, not only as absence of disease, but as a state of good overall physical and mental health. These conditions, taken and “institutionalised” in 1979 by the Farm Animal Welfare Council (FAWC), are still the basis of international legislation on animal welfare. The five freedoms recall the respect for the fundamental and basic needs of each animal, the protection of which is vital especially in captive conditions. Although these requirements are still the basis of Community legislation, in reality the debate on this topic has not yet found a clear definition.

Most experts agree to see animal welfare as a balance between the individual and the environment that surrounds it, where “environment” refers to a heterogeneous group of factors including the physical environment (facilities, density, microclimate etc.), interaction with other animals and humans, the absence of disease or predators²¹. The adaptation to these factors can vary in intensity from case to

case: the animal can be, for example, in a good level of wellness compared to some factors such as the breeding structure, but in a low level for others, such as the health status.

FIVE FREEDOMS



1. FROM HUNGER, THIRST AND MALNUTRITION

by ensuring the animal access to fresh water and a diet that maintains full health



2. TO HAVE AN ADEQUATE PHYSICAL ENVIRONMENT

giving the animal an environment including shelter and a comfortable resting area



3. FROM PAIN, INJURY, DISEASE

foreseeing them or diagnosing and treating them quickly



4. TO EXPRESS THEIR SPECIFIC BEHAVIOURAL CHARACTERISTICS

of their species providing the animal with sufficient space, proper facilities and the company of other animals of their own species



5. FROM FEAR AND DISTRESS

ensuring the animal conditions and care that do not involve psychological suffering

From this consideration emerges that one cannot talk about health only in terms of its presence or absence, but also that wellbeing varies from very bad to very good²². To testimony the strong interest on the subject in recent years various projects have started to measure the level of animal welfare, based on specific and objective indicators that can reflect the psychophysical condition and the level of stress of animal health: some of these are the Welfare Quality® and the RIBECA project. Also in the Rural Development Programmes animal welfare has found ample space. In particular, Measure 215, relative to payments for animal wellbeing, financially supports the dissemination of methodologies and farming conditions with high animal welfare content, more than the minimum limits imposed by specific regulations, with the aim of increasing the competitiveness and profitability of livestock farms.

Although the scientific community has established the characteristics of animal welfare and its measurement mode, in the public opinion the perception of well-being is far from unique and maintains a strong characteristic of subjectivity, due to ethical considerations. In other words, if for science there is a substantial agreement on how to define the state of animal welfare, in common understanding the conditions considered “adequate” vary according to the conception of the animal itself and the adopted perspective.

4.2 Animal welfare in modern livestock

As with all food products, also livestock production is constantly increasing and this involves, on the part of the operators a constant search for efficiency. This, one

should admit, has over the years resulted in some critical situations regarding some aspects of sustainability, such as animal welfare, which have been put into second place compared to the economic factor, which has always been the main driver of a productive enterprise.

It is also necessary to observe, however, even though not always at the same speed among the various industrial sectors, that things are changing and many entrepreneurs have started considering animal health among the subjects relevant to the sustainability of their business, especially when the vision is far-sighted: it is only in medium or long-term horizons that investment without immediate return, such as those of animal welfare, give their fruits.

In the case of livestock, the principles laid down by the five freedoms should be guaranteed mainly by paying attention to the rearing phase, but also to transport and slaughter. To regulate these and other factors the legislation, first Communitarian and then National, intervened establishing specific criteria that represent minimum thresholds to be respected. Intervention in legislature has been joined, with a remarkable growth in recent years, by the development of a large number of standards and voluntary initiatives, brands and certifications to ensure compliance with certain characteristics in breeding, permitting, among other things, a higher level of well-being. It is for example the case of awards for animal welfare and standards for breeding proposed by nongovernmental organisations such as Compassion in World Farming and the RSPCA, or product standards such as organic, for the attainment of which are provided stringent requirements for farming conditions.

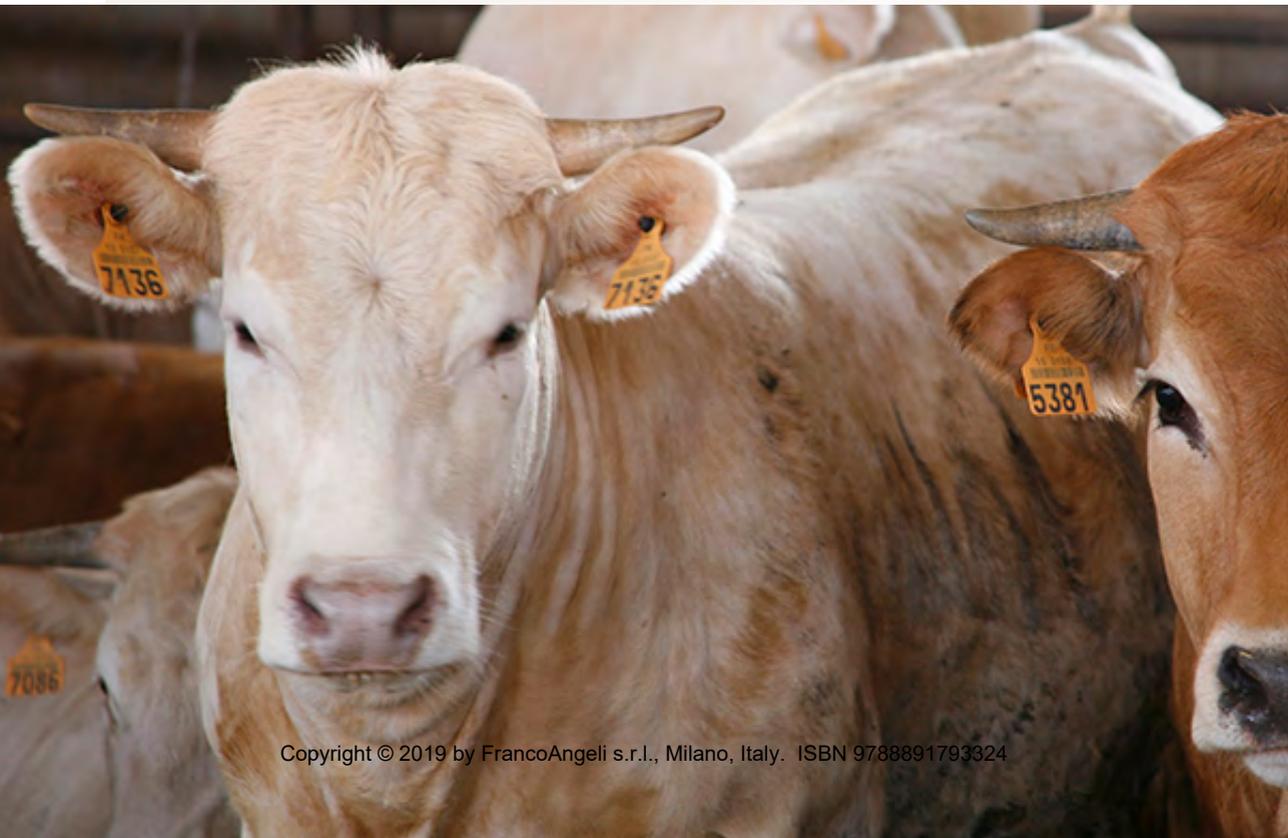
WELFARE QUALITY®



Welfare Quality® (www.welfarequality.net) is a research project funded by the European Union to thoroughly examine the studies on animal welfare, and identify measuring parameters. Launched in 2004, the project was attended by for-

ty-four institutes and universities, representing thirteen European countries and four Latin American countries that have co-operated in an integrated manner in order to implement monitoring systems in breeding to improve animal welfare on the farm. Welfare Quality® ended in 2009 with the presentation of the first protocols for measurement and classification of animal welfare on the farm, addressed respectively to cattle, swine and poultry.

The identified systems are based on a combination of scientific methods of detection of well-being with the classification criteria of the farms into four categories, from “poor” to “excellent”. The assessment of animal welfare is based on four principles: adequate housing, proper nutrition, good health and appropriate behaviour. Within these principles, twelve welfare criteria, distinct but complementary, have been highlighted.



MEASURING WELL-BEING: THE RIBECA PROJECT

RIBECA, "Application of an innovative system of evaluation of animal welfare in beef cattle farms", is a two-year project, funded by Mipaaf and coordinated by the CRPA Foundation, involving 7 Piedmont and Veneto beef cattle farms run by young farmers and their associations, Asprocarne and Unicarne. The project, which ended in November 2015, was aimed at developing an innovative system of detection and welfare assessment in cattle

for fattening, taking into account the recommendations of the EFSA Scientific Opinion (2012) on the welfare of beef cattle: the indications provided in this Opinion concern structural and managerial aspects, such as the types of housing, unit surfaces to be assigned to each animal, head per box, floors and bedding materials, control of the microclimate inside the barns, distribution of food and drinking water, human-animal interactions, mutilation and disease control.

The evaluation system perfected as part of the project involves both the assessments carried out directly on animals based on the Welfare Quality Protocol®, and the assessments of the farm environment and management procedures based on the IBA Protocol (Wellbeing Index of the Farm), a methodology developed by the CRPA in collaboration with the Department of Agricultural Management Systems, Food and Forestry (GESAAF) of the University of Florence.

The project led to the development of a checklist for the detection of animal welfare and an input program, cal-

culatation and verification of the requirements of current legislation and the EFSA recommendations, used directly by farmers on their own farms.

The evaluation system involves the compilation of a specific company checklist at the livestock farm, the inclusion of data collected in a special software, the calculation (automatic) of the obtained scores and the positioning of the company in a wellbeing classification (1 = company with poor level of welfare to 6 = company with high level of welfare), the identification of critical points, possible improvements and assessments also of their economic viability. Recently, the CRPA has developed a system of animal welfare evaluation similar to RIBECA, used in pig breeding and fattening.



THE SAI PLATFORM (SUSTAINABLE AGRICULTURE INITIATIVE)

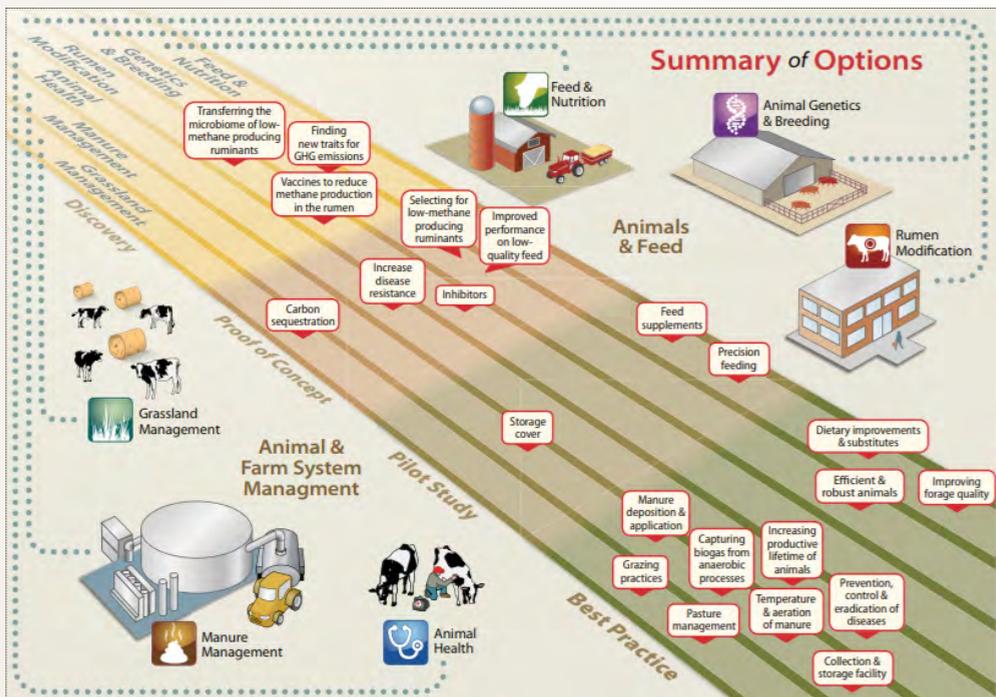
In order to catalyse a change in the food industry, some producer companies of wide consumption goods have established, in 2002, the platform for "Sustainable Agriculture Initiative" (SAI Platform).

Today the initiative involves 90 companies in the food and drinks industry. Their goal is to increase knowledge of sustainable agriculture and communicate with an increasing number of stake-

holders. Among the various initiatives there is the standard "Farmer Self-Assessment" (FSA) that was designed for analysis and improvement of sustainability on farms.

The standard, designed for the analysis of the European context, has been the subject of a pilot project to adapt it to the Italian reality focusing attention on the aspects considered relevant. This test had main players such

as INALCA, DQA - Agri-Food Quality Department and Coldiretti and has permitted to identify possible improvement actions as well as any measurement tools.



SURVEY ON THE MAIN ASPECTS OF SUSTAINABILITY FOR ITALIAN BREEDERS AND STAKEHOLDERS

One of the preparatory activities for the improvement of sustainability in the livestock sector is aimed at examining and, where possible, measuring the perception of the sector's operators on the topic. For this purpose, the collaboration of Coldiretti with INALCA allowed to engage a heterogeneous sample of farmers in the beef industry as well as public subjects and private individuals of particular importance (MIPAFF, McDonald's, COOP, Barilla...), with the aim of understanding the aspects and related practices of sustainable management of most interest. The themes touched from the sur-

vey are those mainly involved in sustainability issues such as company management, environmental impacts, animal well-being, ethical and social aspects. In practice every stakeholder was asked to assign a score that allowed to quantify applicability or relevance of that aspect compared to its presence in the bovine supply chain. The elaborations have identified that among the most relevant topics are to be **found animal welfare, the management of the company, ethical and social aspects**. On some themes the two samples offer very discordant results. An example are

the related questions to the reduction in use of antibiotic drugs and fight against illegal hiring: both the questions registered a high interest score for stakeholders (companies and public institutions) and very low for breeders. This dichotomy highlights how some themes related to sustainability are interpreted and lived completely differently inside the supply chain. This discrepancy underlines once more the importance of drawing up transversal and integrated guidelines at all levels of the livestock supply chain for sustainable development at all levels of the livestock supply chain.

Questionnaire questions	Animal welfare	Company management	Ethics and social	Breeder results	Stakeholder results
What value is attributed to the correct management and improvement of animal welfare				4.64	4.73
Importance of management and decrease in the use of antibiotic drugs				4.13	4.73
Importance of fighting illegal hiring and, in general, the respect of collective agreements at work				3.77	4.73
Importance of financial stability and investment planning				4.43	4.55
Importance of a balanced diet for livestock and adequate space for animals				4.62	4.45
Importance of correct management of company safety and health care				4.45	4.36
Importance of fair remuneration and freedom of association				4.40	4.36
Importance of the company's environmental impact (<i>consumption of water, emissions and management of manure, maintenance of biodiversity</i>)				4.06	4.18
What value is attributed to the transparent management of company ethics?				4.36	4.18
Importance of the company's ability to integrate local communities (job creation) and to support the territory				3.68	4.18
What value is attributed to the culture of corporate and managerial improvement of the farm?				4.23	4.00
What value is attributed to the management of environmental aspects?				4.15	4.00
Importance of energy efficiency management and use of renewable sources				3.87	4.00
Importance of proper staff training through the organisation of specific courses				3.68	4.00
Importance of an improvement plan in the selection of suppliers (<i>animal genetics, food outsourcing and national origin</i>)				3.89	3.91
Importance of a commercial positioning and access to the company market through the definition of contracts				4.23	3.73
Importance of the choice of sustainable supplies and raw materials				4.02	3.73
Importance of the company's ability to adhere to production chains aimed at conserving traditional breeding and processing systems with reduced environmental and climatic impact (e.g. designations of origin)				3.72	3.64
Importance of management and improvement of well-being during transport				3.45	3.64
Importance of management control and access to finance				3.85	3.55

Results of the questionnaire sent to stakeholders and breeders, complete with all the questions ordered according to the priorities expressed by the interviewees (1 minimum - 5 maximum). The topics of greatest interest were highlighted, mediated on the basis of the results of the analysis of the questionnaires compiled by breeders and stakeholders.

Extensive or intensive breeding?

Today the issue of animal welfare is directed especially towards intensive farming, generally accused of offering lower conditions of animal welfare and respect in comparison to more “traditional” and extensive forms. Behind this statement there is a complex issue, namely the inability to objectively define what are the characteristics of an “intensive” or “industrial” farm.

Although the term “intensive” is commonly used both in legislation and in common language, there is actually not a unique and precise definition. One of the few references is in the **European Convention for the Protection of Animal Husbandry** of 10th March 1976 which defines intensive farms, “*that primarily employ technical installations managed principally by means of automatic devices*”. A definition both broad and vague. A second suggestion, more specifically, is provided by **INEA** (National Institute of Agricultural Economics) in a report from 2012, in which it identifies the intensive rearing livestock as a way in which man has the control of both of space available and of animal resources. However, even in this case, there is some ambiguity: as in the case of “pasture grazing” farms when the animals are sheltered in warehouses when there is intense cold or snow: in this case one necessarily turns to food rations, thus the “resources” available to the cattle, and the space to be assigned to each of them are controlled.

When the judgement of the well-being is based on the conditions and on the place of farming, one tends to look favourably on pasture grazing in preference to those in the barn, considered more “industrial” and less respectful of standards of animal welfare. In reality, **both methods**

have advantages and weaknesses, and it is important to remember that they refer to different breeding requirements, which are derived from the characteristics of the territory and the fertility of the soil, but also the economic sustainability of companies.

In the case of **confined** breeding (barn, sheepfold, pigsty, henhouse, etc.) which obviously provides less space, the management of the animal is more **precise** and **accurate**: the animals are checked daily, with the possibility of a timely detection of problems of various associated nature, for example, in diseases or nutritional problems. In this case, also, it is easier to prevent any harmful infectious diseases for livestock or humans, important especially in highly humanised environments.

In breeding in the **open** (pasture grazing, open-air) typical of northern European countries or America, which have large agricultural areas, the animal is left in the wild for most of its life. In this case there is certainly more freedom of movement, but you must consider that the production cycles are getting longer and the degree of control in the event of illness, bad weather or predator attack is less. It is therefore clear that the choice **between extensive and intensive is not so distinct**, both because there are no fixed definitions, and because both breeding models have advantages and disadvantages that need **to be judged with a global vision** that takes into account many aspects. Therefore, in general, the type of livestock breeding is not the only criterion on which to base the measurement of well-being: it is not the case that a structure with high densities, but handled scrupulously, providing an environmental enrichment and innovative

infrastructures, necessarily offers conditions of wellness worse than one with a lower density, but handled with less care.

What the law says: minimum criteria to be respected

A first step in the evolution of the legislation is represented by the Amsterdam Treaty of 1997, in which animals are defined as “**sentient beings**” and are no longer considered only food. Subsequently, in the White Paper on Food Safety published in 2000, the Commission proposed a set of standards by highlighting the close relationship between animal welfare and food safety.

The significance of the issue of animal welfare at legislative level, finally, is also found in the Common Agricultural Policy (CAP), which has included since 2007 animal welfare among the criteria required to be met in the context of so-called “**conditionality**”, subordinating the economic support for farmers with compliance to a series of sustainable requirements that specifically concern animal welfare²³.

Within the complex **body of legislation** currently in **force**, it is possible to distinguish **horizontal and vertical legislation**. The first dictates the lines of appropriate behaviour in all species of food-producing animals, while the second enters into the specifics of certain animal species.

With regards to horizontal legislation, amongst the acts developed by the European Commission these should be remembered:

- **directive 98/58/CE** disposes the minimum standards for the protection of all animals on farms, containing provisions regarding animal control, freedom of movement, livestock buildings, automatic systems, feed and mutilation;

- **regulation (CE) No. 1/2005** on the protection of animals during transport, which lays down the provisions concerning the liability of operators and the training of animal handling personnel and the controls based also on the use of new technologies, space during transport, the duration of the journey and the pauses, the rules for long journeys and for animal handling operations during their loading and unloading;
- **regulation (CE) No. 1099/2009** on the protection of animals during slaughter, which instructs on the provisions on the responsibilities of the slaughter house, staff training, housing modes in the lairages and animal movement, innovative systems of stunning and killing the animals and the verification of their efficiency.

The vertical legislation concerns the **different species of animals for income** and, in particular, the following categories of production: breeding and fattening pigs, calves (i.e. bovine from 0 to 8 months of life), laying hens and broiler chickens. These rules aim to establish criteria relating to the management and structural aspects finalised at protecting the animals, setting minimum requirements for the elements that affect the welfare conditions of the different species, such as housing density, environmental control, paving, supply of food and water, etc.

The crime of animal mistreatment

The acknowledgement of Community indications means that Italy is in line with other European countries in terms of safeguarding the minimum conditions of animal welfare. A peculiar aspect of Italy, however, is made up of the larger number of controls resulting from the pres-

ence in the Criminal Code of the **offense of cruelty to animals**. Article 544-ter of Law 198 of 2004, amended by Law 201 of 2010, states that there is a crime when an animal is subjected to injury, abuse, unbearable conduct or hardships, or to treatments from which cause damage to its health or moreover when it is subjected to the administration of prohibited substances. The offense is connected

with the **exercise of the profession**, and all persons who come into contact with the animal in the breeding, transport and slaughter are punishable.

The inclusion in the Criminal Code leads to a **widening of the prohibitions** with respect to the provisions of the Community legislation (any act involving unjustified suffering to the animal is potentially punishable), but also to a widening of the

	BREEDING	TRANSPORT	SLAUGHTER
 EGG LAYING HENS	DIRECTIVE 98/58/EC, concerning the protection of animals on farms. DIRECTIVE 1999/74/EC and DIRECTIVE 2002/4/EC, concerning minimum standards for the protection of laying hens.	REGULATION (EC) No. 1/2005 of 22 nd December 2004 on the protection of animals during transport and related operations.	1099/2009 of 24 th September 2009 on the protection of animals at slaughter.
 CHICKENS FOR MEAT	DIRECTIVE 98/58/EC, concerning the protection of animals on farms. DIRECTIVE 2007/43/EEC laying down minimum standards for the protection of chickens kept for meat production.	REGULATION (EC) No. 1/2005 of 22 nd December 2004 on the protection of animals during transport and related operations.	REGULATION (EC) No 1099/2009 of 24 th September 2009 on the protection of animals at slaughter.
 PIGS	DIRECTIVE 98/58/EC, concerning the protection of animals on farms. DIRECTIVE 120/2008/EEC laying down minimum standards for the protection of pigs confined for rearing and fattening.	REGULATION (EC) No. 1/2005 of 22 nd December 2004 on the protection of animals during transport and related operations.	REGULATION (EC) No 1099/2009 of 24 th September 2009 on the protection of animals at slaughter.
 CALVES	DIRECTIVE 98/58/EC, concerning the protection of animals on farms. DIRECTIVE 119/2008/EEC laying down minimum standards to protect calves confined for rearing and slaughter.	REGULATION (EC) No. 1/2005 of 22 nd December 2004 on the protection of animals during transport and related operations.	REGULATION (EC) No 1099/2009 of 24 th September 2009 on the protection of animals at slaughter.
 BOVINE	DIRECTIVE 98/58/EC, concerning the protection of animals on farms.	REGULATION (EC) No. 1/2005 of 22 nd December 2004 on the protection of animals during transport and related operations.	REGULATION (EC) No 1099/2009 of 24 th September 2009 on the protection of animals at slaughter.

spectrum of the persons responsible for monitoring. Any supervisory body active in the sector of food business operators (from the traffic police to the NAS – Italian Food Anti-sophistication police) can in fact carry out controls and file a complaint. It should also be remembered that in Italy a “National Plan for Animal Welfare” has been active since 2010; it defines the criteria and monitoring programs by the competent Sanitary Authority with the aim not only to verify the application of national and Community legislation concerning the **protection of animals on farms**, but also to provide information, explanations and guidelines for the breeding of various species.

The pursuit of excellence: standard and voluntary criteria

For more virtuous operators maintaining animal welfare is not a “plus” accessory, but the daily *modus operandi*, and results in a number of specific practices well-integrated into the business management system. Not only, in addition to the practices established by law, the most sustainability-conscious organisations have **voluntarily** decided to implement action protocols or to adopt additional protections on the welfare of farm animals. In this context, in Italy, there are many initiatives, promoted both by institutional entities and associations, to improve farming conditions further: obviously these excellences **only represent the “best practices”** to which the industry is leaning towards (or should lean), with time tables and effectiveness which vary from case to case.

Among the notable initiatives there are certainly those of a few international non-governmental organisations, who have rallied to ask producers to ensure

additional measures of animal protection than those provided by law. One of these is **Compassion in World Farming (CIWF)**, an NGO present at global level since 1967 that promotes more respectful animal wellbeing farming systems. Since 2007, Italy has started an **Animal Welfare Award** program, through which it promotes the use of voluntary measures to protect specific-species animal welfare. The measures vary from award to award, but can be attributed in general to the following main areas: a **density** of less breeding within the limits of the law, the absence of systematic **mutilations**, the presence of **environmental enrichments** and adequate space so that the animals behave naturally.

Another case is represented by brands and voluntary certifications, such as **organic**, for the attainment of which certain animal welfare criteria must be met. In general, **organic livestock production is closely tied to the land**, and the number of head to rear depends on the area available to the farm. The farming method should meet the ethological and physiological needs of the animals, thus allowing the expression of natural behaviour and ensuring adequate living conditions. The facilities for breeding must also ensure sufficient free space available to the animals and allow outdoor access, even in winter. Animals must be fed with vegetable products obtained by the organic production method, possibly grown on the farm. As for veterinary treatments, remedies should aim to stimulate the immune system of the animal. A maximum of two drug treatments per year are permitted. Finally, there are many companies that, despite not joining standard or special certifications have voluntarily developed additional protocols containing measures to protect animal welfare.

The most common interventions include maintaining the animal outdoors for part or all of its life cycle, the offer of environmental enrichment and maintaining a farming density less than the legal limits. Another case is constituted by the supply policy of manufacturers or the MMR,

according to which suppliers are only accepted whose products fulfil certain criteria of well-being: for example, the choice of some distributors and processing companies only use eggs from free-range hens.

MANUAL FOR THE WELFARE EVALUATION OF THE IZS CATTLE FARM OF BRESCIA

The “Manual for the welfare assessment and bio safety in breeding cattle for meat”, prepared by the National Reference Centre for Animal Welfare (CRENBA) and published by the Livestock Institute of Lombardy and Emilia Romagna, addresses the need for creating a balanced and objective assessment system, easy to apply, that also allows comparisons between different farms on the basis of the measurements themselves, ensuring greater objectivity of the assessment provided.

According to the developed methodology, the evaluation of the welfare level of a farm includes both aspects relating to the structures and management (evaluated through the so-called “non-animal based measures” - N-ABMS), and those linked to the animals’ reactions to their living conditions (measured through the “animal-based measures” - ABMS).

The choice of the aspects to be evaluated fell on those easily measurable by objective surveys in almost all the Italian beef cattle farms. The ultimate goal is to compare the different farms on the basis of these assessments, ensuring a greater objectivity to the assessment provided. The assessment on farm animal welfare and bio-security is done through a checklist consisting of 56 items, divided into 5 areas: corporate and personal management; facilities and equipment; animal based measures (ABMs); bio-security; great risks and alarm systems. The result of the evaluations is a numerical value expressed on a scale from 0 to 100, capable of identifying the general conditions of well-being of animals.

The system is evolving in order to be integrated with the proper management of the veterinary drug, an indissociable part in the judgement of animal welfare.



FREQUENTLY ASKED QUESTIONS

IS IT TRUE THAT BREEDING FARMS USE AN INDISCRIMINATE AMOUNT OF ANTIBIOTICS?

No. The use of antibiotics on farms is subject to the compliance with strict rules. Not only is preventive treatment prohibited, but drugs can only be used in the presence of diseases and after prescription. Drugs permitted are those authorised by the health authorities and their use must be limited in time. To minimise the risk for people, it is compulsory to comply with the “suspension period”, i.e. waiting a certain number of days after the discontinuation of treatment before slaughter. In any case, the problem of **antibiotic resistance** (i.e. the appearance of bacteria which have developed resistance to certain antibiotics) is very serious and important, to the point that the WHO has drawn to an overall approach that regards livestock, but also the use of non-suitable antibiotics in human medicine.

ARE HORMONES PRESENT IN BEEF?

In Europe the use of substances with hormonal effects is prohibited in the livestock sector (bovine, poultry and pork chains) since 1981. Their use, furthermore, besides being prohibited by the regulations would be useless, if not counterproductive.

WHAT ARE THE CONTROL MEASURES ON TRACEABILITY AND SAFETY OF MEAT IN ITALY?

The quality and food safety, in Italy as well as throughout the European Union, are such a priority as to consider the Regulations on food safety among the EU regulatory milestones. Amongst all control systems activated in the last few decades, the most important are those related to the traceability and labelling of meat products. The European strategy is to prevent any contamination of foodstuffs from substances present in the environment or due to human activities (preventive actions), and create a network of controls that constantly monitors the presence of residues of substances in food that could be harmful to public health (control actions). Among the preventive actions, is a self-control plan by all operators in the food sector, implemented with the application of HACCP (Hazard Analysis and Critical Control Points). This, in particular, aims to prevent the presence in food of substances potentially harmful to the human body, from a downstream control of the foods that end up on our tables to controlling each stage of their production. With regards to control measures, since 2006 acceptability limits of the contaminants have been defined in foods such as nitrates, mycotoxins, heavy

metals and dioxins.

At the same time, research organisations have been commanded to carry out a consistent scientific analysis of the impact that the known contaminants can have on human health, and the potential toxicity of new substances used in agriculture.

For six years, moreover, three Regulations (149, 260 and 839 of 2008) were adopted relating to the maximum limits for pesticide residues (MRLs) in foodstuffs, for the use of pesticides on crops intended for animal feed. The reliability of these limits is verified by the EFSA (European Food Safety Authority), an independent body that provides scientific advice on all matters that affect food security. In Italy, however, the Ministry of Health annually issues the National Plan for the Search of residues (PNR), which shows the results of the analysis regarding the presence of residues of toxic substances in food.

According to the NRP Final Report of 2017, the results of the monitoring plan have shown that as many as 99.91% of the samples were in accordance with European regulations.

ARE GMO DANGEROUS?

In the debate on food safety, one of the most contentious issues definitely concerns Genetically Modified Organisms

(GMO), often accused of representing a danger to human health and the environment. The question is delicate, because it brings into play different points of view.

What is a GMO? Literally, the term “genetically modified” refers to any “organism whose genetic material has been altered in a way that does not occur naturally by mating and/or natural genetic recombination”. Indeed, the improvement or modification of the genetic characteristics of an animal or a plant species has been common knowledge for ever.

So it is good to clarify that the GMO techniques “on trial” are those that have developed over the last 40 years, that permits the change of some features of living species “in the laboratory”: for example, you can increase the resistance of a plant to pesticides or certain parasites, improve the nutritional profile and the ability to adapt to adverse weather conditions (e.g. increasing the resistance in case of drought). The main GMO crops worldwide are **soybeans, corn and cotton**.

In the document “20 Questions on Genetically Modified Organisms”, the WHO said that there is no evidence that GMO foods currently on the market represent a risk to health. Similarly, no negative effects on health has been noted from the consumption of GMO foods in the countries where they have already been approved. However, their use in the agri-food sector is opposed by a considerable part

of public opinion, for reasons mainly related to environmental and ethical issues that have little to do with food safety itself.

IS IT TRUE THAT THE MEAT FOUND IN THE SUPERMARKET ALL COMES FROM ABROAD?

The Italian beef production is insufficient to meet domestic demand: currently about 40% of live calves and meat is imported from other European countries.

Live calves of beef breeds, which are characterised by a high level genetic profile, are bred in Italy integrating perfectly with the wide availability of quality corn in the Po Valley and the increasing possibilities of pastures and fodder for the reduced production of durum wheat, especially in the centre-south. Through breeding techniques perfected over the years and in particular the best practices in nutrition and in respect of animal welfare, the Italian chain ensures the quality and safety of meat “bred in Italy”. Thanks to the traceability system, on the label of the final product it is always possible to check the animal’s country of origin.

ON FARMS ARE ANIMALS REALLY ABUSED AS SHOWN ON SOME TV SHOWS?

The respect of animal welfare in farming, transport and slaughter has taken on great significance in recent years, in the European Union as well as in countries that export meat

to Europe, obliged to comply with standards equivalent to those applied to EU members. The reasons are many, but beyond the undoubted ethical value and therefore the attention of public opinion and of the control bodies, there is also a purely economic reason: potential stressors and poor living conditions not only create conditions of unnecessary suffering to the animal, but also low quality meat and low productivity levels.

The European Union is particularly advanced in the field of welfare of farm animals: the Commission is in fact working hard to increase the level of animal welfare in the member States, with continuous investment in the improvement of regulatory standards. An effort that leads Europe to invest an average of 70 million Euro per year in actions aimed solely to the protection of animal welfare.

In the European Union all those rearing methods that cause suffering or injury to livestock are prohibited, and it requires that animals are observed daily and, if necessary, treated.

Not only that, according to European legislation freedom of movement to all animals must be guaranteed, while the equipment for the administration of feed and water must be designed, constructed and installed so as to minimise the chances of food or water contamination, and the negative effects of competition between animals.

IS IT TRUE THAT CHICKENS GROW IN CLOSED CAGES?

No, it is not true. And to confirm this, simply visit one of more than 6,000 Italian farms, where all the chickens, turkeys and other poultry for meat are not kept in cages, but on the ground, free to roam in spacious and bright areas, moving on layers of straw or wood chips that are absorbent and hygienic. In some cases, there are also open-air farms. For over 50 years, from the early '60s, the "battery" breeding of chickens for meat does not exist.

This prejudice (common today to as many as 8 out of 10 Italians) is mainly due to the legacies of the past and to an erroneous confusion between the rearing of broiler chickens and that, still widely diffused today, of egg laying hens, where the animals are no longer bred in batteries, but in cages according to the most recent Community legislation on animal welfare, so as to ensure the animals ease and health, together with hygiene of eggs produced.

Next to the horizontal rules, which guarantee the welfare of any animal species in farming, transport and slaughter, also numerous vertical regulations are in force, which establish the welfare requirements in the breeding of each species, including egg laying hens or broilers.

The commitment of the poultry sector in ensuring a smooth and optimal application of these laws throughout the country has resulted in important initiatives, such as

the drafting of the "Operating Procedures for the protection of poultry during transport" manual, in collaboration with the Italian Company of Preventive Veterinary Medicine and with the approval of the Ministry of Health. Still awaiting approval by the same Ministry is, on the other hand, the "Proper operating practices for poultry hatcheries" manual. Finally, the poultry industry (UNAITALIA) has promoted a number of training courses on animal welfare for livestock farmers throughout the country, training more than 1,500 farmers.

Now all broilers are raised on the ground and sexes are separated in special sheds, where the density is usually maintained at around 30-33 kg of live weight per square meter (corresponding to a maximum of about 12 chickens, with an estimated average weight to 2.5 kg) at slaughter. Breeding on the ground is, among other things, the preferred choice considering the positive effects on the organoleptic characteristics of the meat, which are in this way much more pleasing to consumers.

The current laws in Italy (Legislative Decree. 27/09/2010 n. 181) provide that both the owner, and the holder are responsible for animal welfare and the application of the measures foreseen. The norm sets a maximum stocking density equal to 33 and 39 kg/m² depending on the environmental conditions of the farms. In an interview in March 2014 for the magazine Food, the president of UNAITALIA Aldo Mura notes still many prejudices

and myths resist regarding poultry meat: "For example, only 3 out of 10 Italians know that 99% of the chicken we eat in Italy it is bred in our country and to verify this all you have to do is simply read the label. Similarly, over 80% of Italians ignore that the breeding of broiler chickens happens on the ground and not in a cage". To inform consumers properly, UNAITALIA launched the blog www.vivailpollo.it, a site with answers also to doubts and curiosities.

IS IT TRUE THAT CALVES ARE BRED IN CAGES?

Contrary to popular belief, the rearing of calves is not allowed in cages. Animals should in fact remain exclusively in barns and in groups to respect the highly social features that characterise the behaviour of these animals. In this regard, the rules are established by a Legislative Decree July 7th, 2011, n. 126.

They require that no calf older than eight weeks may be confined in an individual pen; each individual pen must not have solid walls, but perforated walls which allow direct contact, sight and touch amongst the calves.

As for the calves kept in groups, instead, the free space available to each calf varies according to the weight: and must be at least 1.5 m² for each calf of a live weight less than 150 kg, at least 1.7 m² for each calf with a live weight of 150 kilograms or more but less than 220 kilograms, and at least 1.8 m² for each calf

with a live weight equal to or greater than 220 kg.

In addition, they must ensure thermal insulation, heating, ventilation and proper lighting in order to maintain the healthy environment and encourage growth and well-being of calves. In addition to these conditions, the building must be able to allow each calf to lie down, rest and stand up without difficulty.

DO PIGS LIVE IN THE DIRT?

Often mistakenly pigs are thought of as dirty animals. Actually pigs, having little ability to sweat, in nature tend to roll in mud to cool off and control pests. When confined in an enclosure of sufficient size, they tend to defecate in defined areas (unlike other farm animals), keeping their rest and activity areas clean. There is also the Legislative Decree of 7th July

2011, n.122 (which in fact is the law that applies in Italy as a transposition of Directive 2008/120/EC), relating to the management of breeding pigs. This standard contains many requirements for the protection of health, in particular in relation to the space available for each animal, the type of flooring and the provision of specific material because pigs can root around.



NOTES

¹ For more information, refer to the website of the One Health Initiative organization (www.one-healthinitiative.com/)

² Regulation (EC) 1831/2003

³ Commission Communication 2015/c 299/04, Guidelines on the prudent use of antimicrobials in veterinary medicine

⁴ The Population Correction Unit is a theoretical value determined on the basis of the average weight of the livestock on which the treatments and number are carried out animals slaughtered in the year in question, taking into consideration imported and exported animals exported to be fattened and slaughtered

⁵ AIA, AISAM ASSALZOO, FNOVI. Good practice for the use of antimicrobial drugs in animals intended for food production

⁶ Zoonosis are infections or diseases that can be transmitted directly or indirectly between animals and humans, for example through the consumption of contaminated food or contact with infected animals. In humans these diseases can have different severity, depending on the type of pathogen and the physical condition of the infected person, with clinical pictures characterised by mild symptomatology up to potentially lethal diseases

⁷ Commission Regulation (EC) 2073/2005 European Union of 15th November 2005 on microbiological criteria applicable to foodstuffs, OJL 338 of 22.12.2005, pp. 1-26

⁸ Opinion of the Scientific Panel on Biological Hazards on a request from the Commission related to the effects of Nitrites/Nitrates on the Microbiological Safety of Meat Products, 2003, The EFSA Journal, 14, pp. 1-34

⁹ The risk assessment explained by EFSA, 2017. Nitrites and nitrates added to food

¹⁰ Regulation (EC) 178/2002 introduced the current food safety model, marking the start of a real re-organization process of the relevant Community legislation

¹¹ Regulation (EC) 882/2004 represents the framework regulation for the organization of official controls on food, feed, health and animal welfare

¹² For more information on the regulations of the Hygiene package, please refer to the Ministry website of Health (www.salute.gov.it/portale/temi/p2_6)

¹³ Food frauds (health and commercial) (www.izsalimento.izsto.it/palimenti/index.php/laspesa/frodi-alimentari)

¹⁴ Reference legislation on food safety (www.izsto.it/index.php/istituto/93-reportdatisanitari/sicurezza-alimentare/535-normativa)

¹⁵ Autorità Europea per la Sicurezza Alimentare, EFSA - European Food Safety Authority

¹⁶ Regulation (EC) 852/2004

¹⁷ INALCA. Sustainability Report 2014, chapter 9

¹⁸ Mipaf List of Italian denominations, filed in the Register of protected designations of origin, of protected geographical indications and of the traditional specialties guaranteed (EU regulation n. 1151/2012 of the European Parliament and of the Council of 21st November 2012) (updated to 2/7/2018)

¹⁹ For more information, see: AICIG, association Italian Consortia Geographical Indications

²⁰ Ministry of Health. "Report on the system of European alert - 2016 "

²¹⁻²² INEA, 2012

²³ Regulation (EC) 1782/2003

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ECONOMIC AND SOCIAL ASPECTS OF MEAT CONSUMPTION

-
- ❖ THE SIZE AND ECONOMIC TREND OF THE SECTOR
 - ❖ ORGANISATION OF THE COMPANIES
 - ❖ THE COST FOR CONSUMERS

Introduction

THE MEAT CHAIN
CONTRIBUTES TO ABOUT
15% OF THE ENTIRE
ECONOMIC RESULT OF THE
ITALIAN FOOD INDUSTRY

THE ORGANISATION
OF AGRICULTURAL
OPERATORS IS
FUNDAMENTAL FOR
THEIR ECONOMIC
SUSTAINABILITY IN THE
MIDDLE AND LONG TERM

WHEN MEAT IS INSERTED
IN A BALANCED DIET
IT DOES NOT INVOLVE
EXCESSIVE COSTS FOR THE
CONSUMER

The economic and social theme in meat production is extremely complex because it takes into consideration very different and apparently distant topics.

*The macroeconomic aspects linked to the performance of the sector in the world and in the various geographical areas must in fact be accompanied by a **territorial analysis** that examines how the companies that make up the sector are organised. Although many people associate the (relatively few) brands of the meat processing industry to the meat industry, it is important to remember how the livestock supply chain lays the foundation of the many companies that manage the breeding farms and, increasingly, the cultivation of foods.*

*This aspect is particularly relevant in **Italy** where the reality of production is characterised by a **large number of family-sized**, or slightly larger, companies which give con-*

tinuity to the tradition over generations in a complex and heterogeneous system highly linked to the rural dimension. On the one hand, these peculiarities have the advantage of passing on quality over time (which is why Italian food is world famous), but on the other hand they make economic sustainability of the companies precarious, increasing, among other things, the risk of abandonment of the territory by the farmers and their families.

*For this reason, **the tendency towards aggregation and forms of stable partnership between companies of various sizes must be seen in a positive way**, as the goal is to ensure economic sustainability, whilst maintaining the original identity. This trend, highly developed in countries that make wealth out of agriculture, allows the organisation of supply chains for better product control. A fundamental aspect of an **“organised”***

***system** is the possibility of better integrating with the various related production systems (meat, milk, cereals), increasing productive efficiencies as much as possible.*

Last but not least is the analysis of the cost for the consumer who is increasingly attentive to food choices. Meat and cured meats are products that are normally placed in a medium-high cost segment but, as shown by the construction of the “economic hourglass”, even in this case the equilibrium pays off: an adequate consumption consistent with nutritionists’ indications does not incur excessive costs for consumers.

In reality the trend that the producers are starting to take into account is “less but better” that is moving purchase preferences towards products of a superior quality, perceived or real, even if higher costs are incurred.

1 THE SIZE AND ECONOMIC TREND OF THE SECTOR

Despite the data over the last 50 years shows a general growth of the sector in the world, a detailed analysis allows us to observe how this growth is neither constant nor homogeneous.

1.1 Evolution in the world

To get a general overview of the sector's performance worldwide it is possible to take into account the data of the historical series of the FAOSTAT database regarding the number of animals bred of the main species (bovine, pig and poultry) in the various regions of the world¹.

As for the bovine species in the world there are raised about 1.68 billion head with a growth of about 48% over the last fifty years. Asia and America are the areas with the highest number bred and with constantly growing trends. Europe, and with it Italy, is characterised by a reduction trend that since 1996 (the year of BSE) has reduced the number of animals raised until stabilisation over the last decade. In Italy alone, the cattle population from 1961 to 2015 was reduced by approximately 40%, resulting in the abandonment and consequent depopulation of the countryside. In 2017 there was a reverse trend, with a gradual increase in the number of cattle raised.

The production of pork is dominated by Asia, where 58% of the 990 million heads bred annually in the world are found. The growth trend shows an increase of about 60% compared to the 1960s, sub-

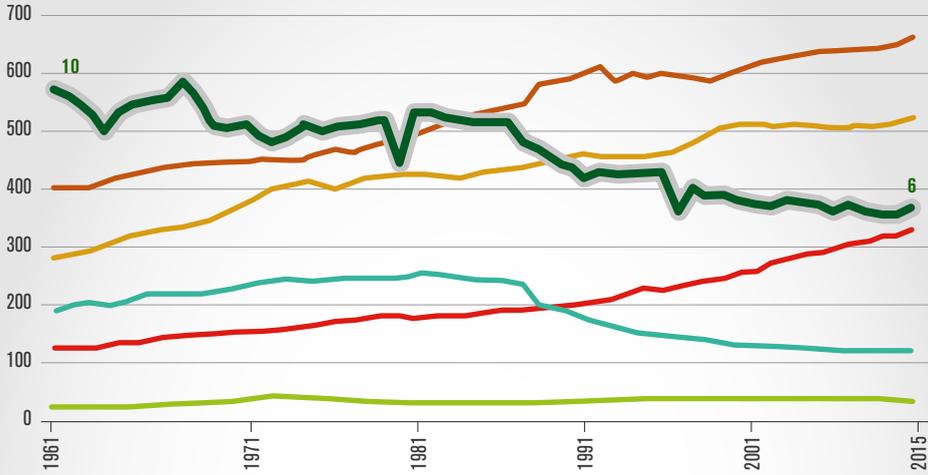
stantially driven by the increase in Asian production. As for bovine herds, also for pigs, data is substantially stable in the last decade. Unlike the other species for which the data are much more heterogeneous, the values for breeding poultry show a widespread increase since the seventies. The overall production has in fact increased by almost 5 times in the fifty years between 1960 and 2010: also in this case Asia is the region where the increase is greater. Europe confirms itself a region with a trend reversal that began in the 1990s, although, unlike other species, the last decade shows a slight increase in the number of head bred. Notwithstanding the fact that the data of the head bred does not closely coincide with the consumption of meat in the same areas due to the phenomena of commercial exchange, this information can help to understand the phenomenon of sustainability in the livestock supply chain and, consequently, help the investment of resources and technologies to mitigate environmental impacts and to better manage the topic of food safety and animal welfare.

1.2 The Italian situation

The agri-food sector in Italy contributes about 15% of the annual gross domestic product, with a total value of around 180 billion Euro. Of these, about 30 derive from the meat sector, of which 10 from the agricultural supply chain, and 20 from processing. The substantial differences

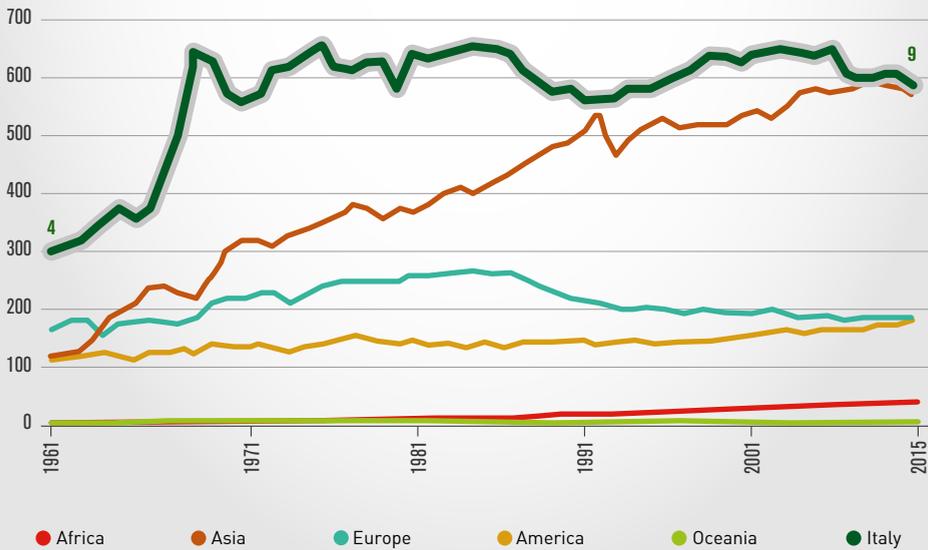
PERFORMANCE OF BOVINE HEAD BRED

millions of animals/year



PERFORMANCE OF PORK HEAD BRED

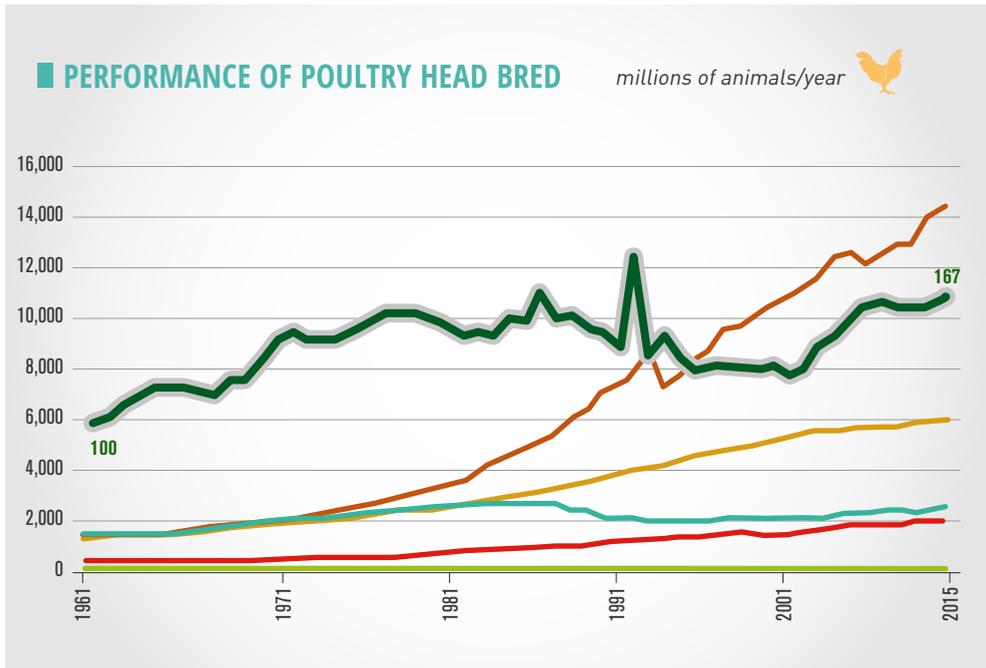
millions of animals/year



Average head on the farm.

The Italian trend is out of scale compared to that of other regions of the world.

Source: FAOSTAT (Live animals, stocks, Cattle and buffaloes e Pigs, 1961-2016).



*Average head present in breeding farms per production cycle.
The Italian trend is out of scale compared to that of other regions of the world.
Source: FAOSTAT (Live animals, Poultry birds, 1961-2016)*

between the three main supply chains lie in the trade balance as well as in the distribution of the value between the agricultural and industrial supply chain.

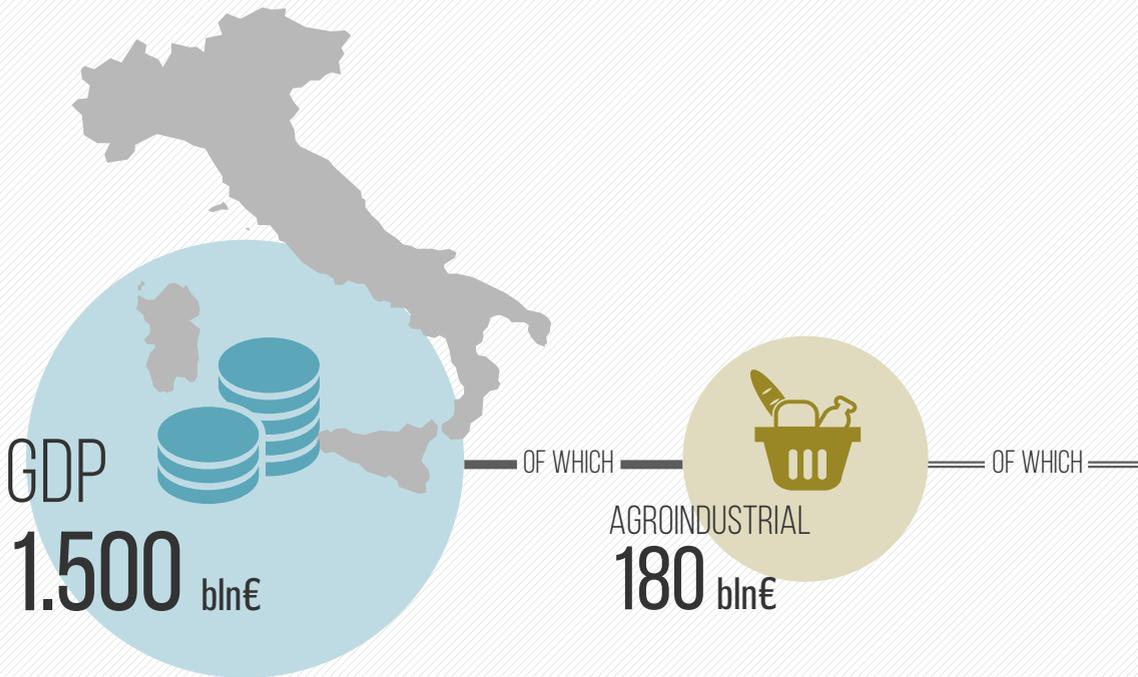
In the case of bovine, the trade balance is negative: Italy is in fact a strong importer of live cattle for fattening and beef (fresh, chilled or frozen, for consumption or subsequent industrial processing). The self-supply rate of our country, obtained from the ratio between production and apparent consumption, is around 50% (ISMEA markets²). Regarding the pig industry, the trade balance of live animals sees imports that are around one million heads and exports almost negligible (a few thousand). In general, more than half of the pigs reared in Italy produce meat used internally, the remaining part (such

as fresh meat or raw materials for cured meats) is imported³. The dependence from abroad is around 40% of the total needs. In the case of pork meat, most of the economic value is generated by the processing industry mainly thanks to the production of cured meats that, among other things, allow our country to export products with high added value both qualitatively and economically. Unlike the others, the poultry supply chain makes Italy self-sufficient with a production slightly higher than requirements. The economic value is generated mainly by transformation with a trend of growth.

MEAT AND CURED MEATS IN ITALY

ECONOMIC DIMENSION OF THE SECTOR

DATA IN BILLIONS OF EURO PER YEAR

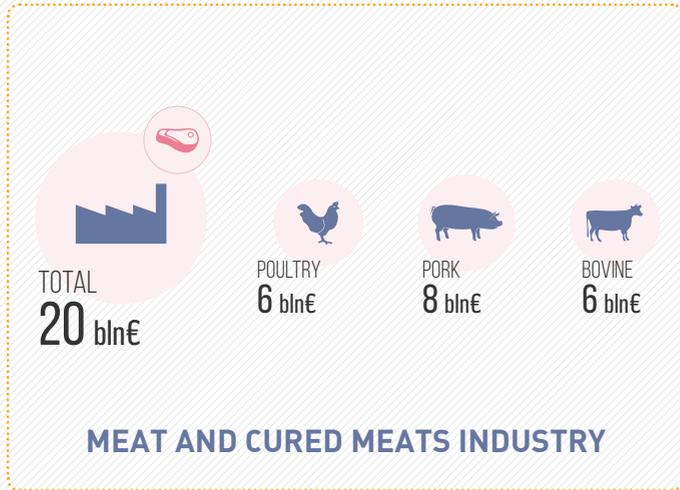


Macro-economic dimension of the meat sector in Italy. The information presented has the purpose of providing a general indication and is the result of reprocessing statistical data published by ISMEA* and ISTAT** that is recommended to consult for any further information or details.

*www.ismeaservizi.it **www.agri.istat.it



OF WHICH



OF WHICH



		HEAD BRED AND NUMBER OF COMPANIES IN ITALY			
		2010		2016	
		COMPANIES	HEAD	COMPANIES	HEAD
TOTAL CATTLE		151,501	5,786,111	129,148	5,568,211
TOTAL PIGS		128,780	9,182,314	133,237	8,402,816
TOTAL POULTRY		6,321	575,000,000	6,973	674,000,000

Source: National database of the IZS of Teramo for the years in question.

The data refers to the annual consistency of cattle breeding (total data, excluding buffaloes) and pigs (total data) and for poultry, to the following categories: broilers, laying hens, quails for meat, turkeys (meat and breeding), geese, ducks and guinea fowl.



2 ORGANISATION OF THE COMPANIES

As is the case in many Italian goods sectors, the agri-food sector is also very articulated and organised into structures, often family-run, of a medium-to-small size. In reality, the trend is slowly changing and the market is moving towards companies of gradually larger sizes and better organised. These are “weak” but unequivocal signals, recordable not only in Italy but also in other territories of the European Union. The growth in size is largely determined by the reduction in the number of active companies that affected both the agricultural sector and that of the first and second industrial transformation⁴. From the ISTAT data it emerges that, in 2013 (latest available public data), the number of breeding farms was equal to about 189,000 units: the greatest presence of livestock farms is found in the northern regions, in particular Lombardy, Veneto, Emilia-Romagna and Piedmont. Only using the physical dimension is not enough to grasp the complexity of the Italian farm universe and its dynamics. To this end, the last General Census of Agriculture⁵ proposes another dimension, the economic one (ED).

The analysis shows that 63% of companies, while playing an important territorial role (in terms of presence, environmental protection and care of the landscape and the territory) from a strictly economic point of view produce a very low income (< 8,000 Euro/year), which must necessarily be complementary to other activities. In fact, diversification of activities is an im-

portant tool used by agricultural companies to achieve economic stability.

2.1 The importance of the “agricultural” dimension in Italian agri-food

The statistical data does not reveal the unmistakable characteristic of the Italian agricultural heritage: its “agricultural dimension”, the cultural values, identity, traditions and social membership that it represents.

Farmers by tradition

The Italian territory is historically characterised by a plurality of agricultural systems with a great diversity of landscapes, agro-ecosystems and socio-economic conditions, that over time have produced a multiplicity of economic realities, production facilities and relative markets.

About 80% of the half a million Italian farms are small businesses, to which must be added the countless practices of auto-consumption. This diversity and ubiquity represents the Italian specificities, on which rests the heritage of great wealth and agricultural biodiversity production that also represents the safest method to maintain the mountain and hill areas.

Some peculiar characteristics of farmer agriculture are fundamental: the different ways of family run businesses, the communities and cooperatives related to the work of land, local roots and the

	FARM'S CLASS OF INCOME		
	 < 8,000 €	 8,000 - 15,000 €	 > 15,000 €
NORTH-WEST	42.0%	13.0%	45.0%
NORTH-EAST	47.2%	12.6%	40.2%
CENTRE	66.5%	10.4%	23.1%
SOUTH	72.4%	10.1%	17.5%
ISLANDS	60.7%	10.9%	28.5%
ITALY	62.8%	10.9%	26.2%

Italian farms for economic dimension (ED)

Source: Table 1.1 p. 78 of 2013 General Agricultural Census

various conservative and sustainable agricultural practices, the control of the reproductive cycle through the reproduction of local seeds, traditional varieties and native breeds. Practices and methods that are now found in many forms of agricultural reality, of family tradition or new settlement, in every Italian region.

Land protection

The presence of these realities is very important and serves to guarantee the preservation and protection of the territory, reducing the continuing depopulation of agricultural areas by bringing back work and employment, thereby reducing the environmental costs (hydro-geological system, the maintenance of the soil and the protection of biodiversity), reconstructing the social and rural landscapes,

ensuring the presence of people in places that might otherwise be abandoned.

Land conservation is achieved mainly by using a wide variety of farm protection policies: it has been seen that severe hydro-geological instability increased when those agricultural activities that were carried out in full harmony with the territory stopped. The cultivated land, in fact, along with forests, play an essential role in stabilising and consolidating the slopes and holding back the river banks, thanks to their high absorption capacity, helping to prevent landslides and land erosion.

The protection of the territory by the farmer, whose maintenance work is essential especially in the marginal areas of the hills and mountain, must therefore be guaranteed by a proper environmental protection policy, supporting and

promoting the activities of the farmer. In the mountains cattle and sheep breeding is an excellent way for monitoring activities through the careful management of pastures.

Since there is a plurality of patterns of agriculture, for the purpose of proper land management, depending on the different production realities, appropriate and diversified measures are necessary, recognising agriculture as a socio-economic model and consequently identifying standards that are appropriate for it.

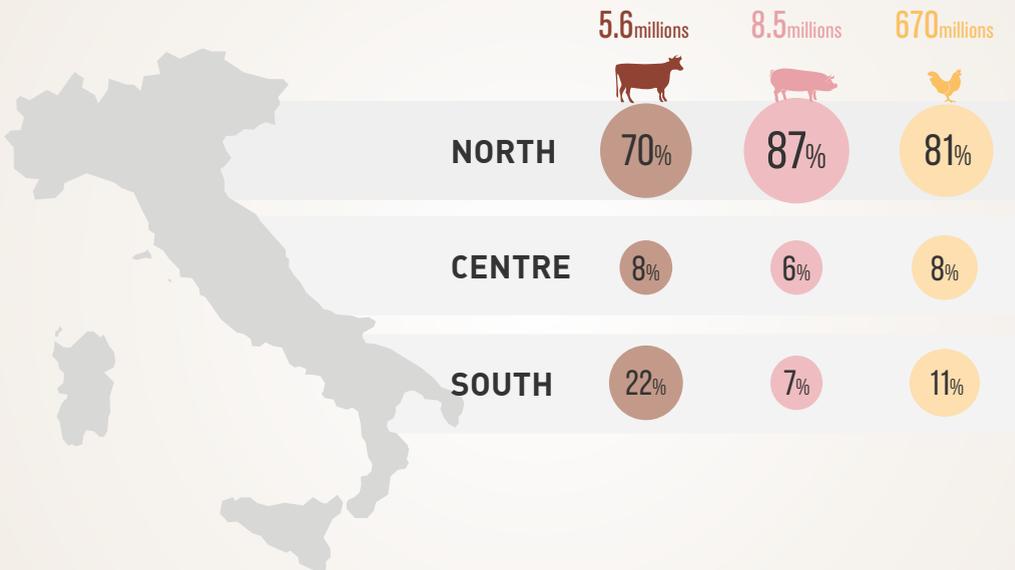
European agricultural policy (PAC) - the

set of rules that the European Union, since its inception, has sought to create, by recognising the central role of agriculture for an equal and stable development of its member countries⁶, is specifically intended to help farmers not only to produce food but also to protect the environment, improve animal welfare and to maintain rural communities economically alive.

The profession of agriculture

The fragmentation of farms makes economic sustainability difficult for them and

LIVESTOCK PRODUCTION IN ITALY



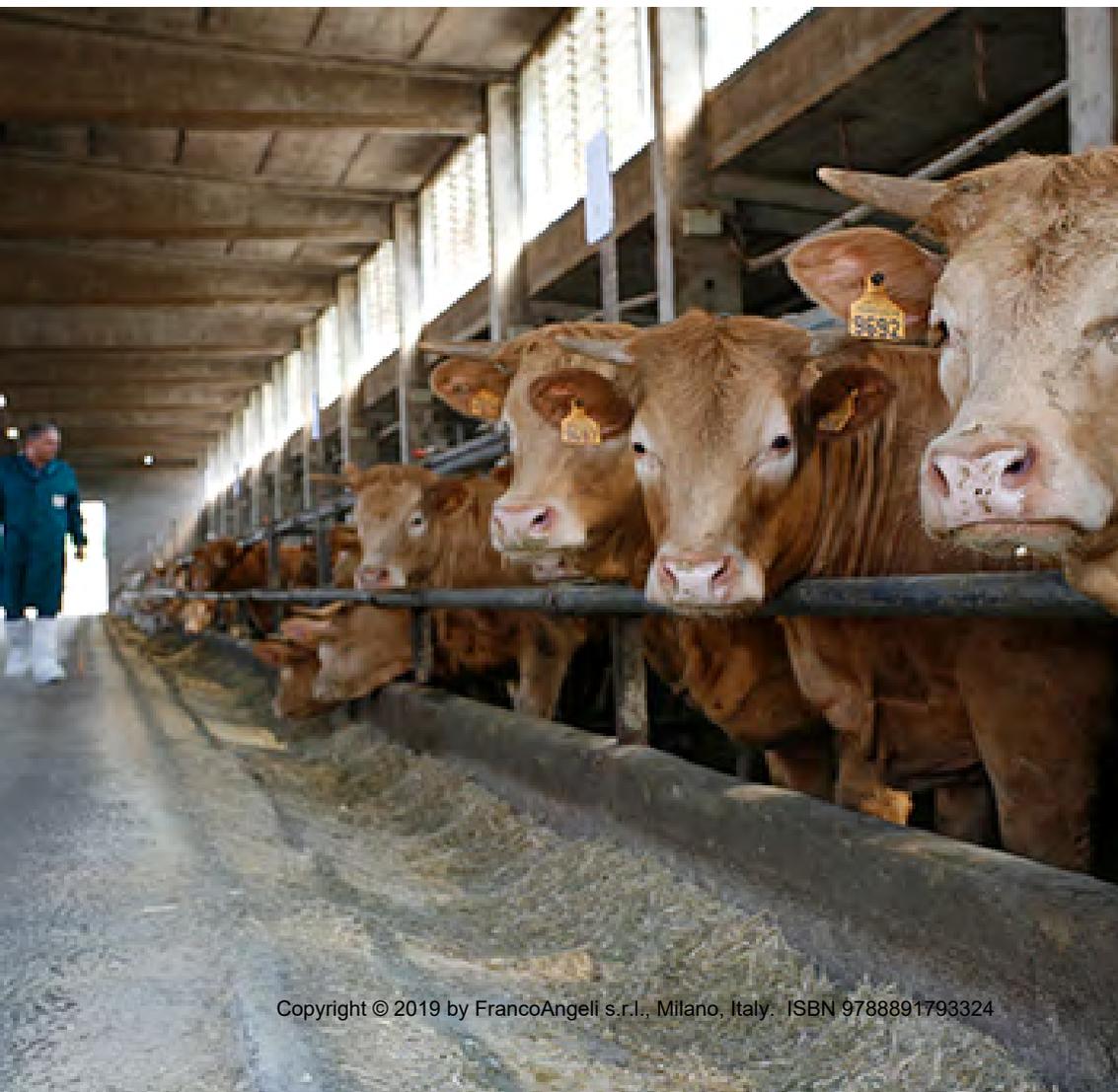
Livestock production in Italy and its distribution.

Data source: IZS Teramo 2016 (bovine, pig and poultry sector), UNAITALIA, 2016 (preliminary data for the poultry sector)

the entire food farming sector, with the risk that farmers and their families abandon the land. For this reason, the tendency to organise themselves into cooperatives or small and big industries must be judged positively, since the objective is to ensure the economic sustainability of the companies themselves, while maintaining their original identity. This trend is highly developed in countries that make agriculture a source of wealth, and allows for the organisation of supply chains which,

as can be seen, are those that provide the most control over the products. Finally, a fundamental aspect of an “organised” system is the ability to better integrate the various related production systems (e.g. Meat, milk, cereals), thereby maximising production efficiency.

This agriculture, “by profession”, is the most representative of the main supply chains for meat production in Italy.

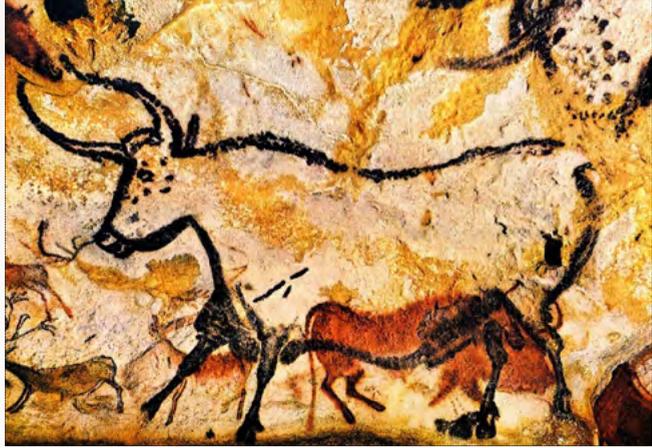


HISTORICAL AND SOCIAL ASPECTS OF MEAT CONSUMPTION IN HUMAN HISTORY

edited by Massimo Montanari and Giovanni Sorlini

The history of man has been, first of all, to continually search for answers to his food needs, at a time when food was the essential reason for survival, the first and unavoidable daily necessity. How can we not think of the vivid images of cattle in the French caves of Lascaux, whose meat was already at that time probably the main source of livelihood for the European primitive man?

At some point in history, however, the pure need for food transforms into pleasure, an element constituting a particular social affiliation; a radical transformation of its original function to the exact opposite, represented by the research of hedonism and cultural belonging. This dual polarity, or rather the change in the function of meat, unfolds a complex history, closely linked to power relations and social inequalities that went with it. The history of this food is closely interconnected to mankind's history, which constitutes one of the basic elements, in each case either the cause or the effect of human events. When trying to identify some of the stages that we consider particularly significant, the first that seems appro-



appropriate to recall is the fall of the Roman Empire: during the centuries III-VI AD, the dissolution of this millennial cultural horizon has indeed given way to the establishment of new political and administrative realities, the turbulent mixing of peoples and cultures, the depopulation of the countryside and the breaking up of the patterns of production and food distribution, present at the time. In this moment in history we are witnessing the depletion of the food model based on the cultivation of the fields, determining the general conditions of food scarcity and, with them, an unquestionable period of hunger. In this period of history in fact the testimony of

war, famine and pestilence are widely documented by historians of the period and with them especially the general demographic decline of the European population. The European man of the III-VI century, from consumer of products obtained from the cultivation of the fields, the typical model of the Roman period, differentiated himself, by significantly using products from the forests, which in those centuries grew heavily at the expense of agricultural land, often not able to be used due to the demographic imbalances of that difficult period. The need to develop a new model of consumption that combined the traditional model of the cultivated ager

with the exploitation of uncultivated areas typical of the barbaric matrix (the so-called *saltus*, a term used by the Romans, not without a pejorative connotation towards the peoples beyond the Alps), determined the process of more food supply systems which together formed the foundations of a food model in which we Europeans still recognise ourselves today.

For meat, we can say that the controlled production model typical of the Romans and based primarily on the rearing of small ruminants in confined spaces, is combined with the spontaneous model of Germanic and Celtic matrix, based on the exploitation of virgin nature and uncultivated spaces, ideal for example for hunting, or the natural breeding of wild pigs.

In this historical phase, in which various food supply systems in different and distant historical and cultural origin are integrated and the cultivation of the fields becomes more difficult because of demographic imbalances, meat becomes once again a mainstream food, the food value "par excellence".

If the Latin doctor Cornelius Celsus considered bread to be the absolute best food, the icon based on the cultivation model of the fields, his colleague Antimo of the sixth century did not hesitate



to consider meat as the "king of food", showing a particular sensitivity to pork; so dear to the powerful of the time, the court of Theodoric in Ravenna. In other words, Antimo was already influenced by food supply models based on the exploitation of uncultivated areas, particularly important in that historical period. Again *ager* versus *saltus*.

In later centuries, characterised in Europe by the consolidation of Christian thought and, with it, the symbolism of oil, wine and bread as food symbols of purity and rectitude, meat however does not lose its core value. In the Europe of the post barbarian invasions, in fact, there seems to finally have been determined an unprecendented and definitive integration between the culture of bread and that of meat, so that both end up enjoying

the statute (no less ideological than material) of primary and indispensable food.

In the Christian era, the polarity between the Roman and barbaric model overlaps with that of the "monastic" and "aristocratic" model: between them they play for the leading role of cultural hegemony. A comparison with many different sides and meanings, where social ethical values clash with those of religious morality, the reasons for fasting with those of power and strength.

How can we not consider Charlemagne to be the archetype of this cultural tension? The first emperor who contributed to the modern picture of Europe left us a historical trace, constantly torn between warlike images of abundance of food, that hinged on the consumption of meat and the Christian ethic of moderation. The first

monarch who made meat consumption an element of his powerful iconography, without denying the values of frugality and moderation in food consumption of the Christian religion that he had embraced, and that animated his political actions. From the start of the eighth-ninth century, thanks to this successful integration between the agricultural food model and that based on the exploitation of forests, the demographic curve starts to rise again, and with it, deforestation, land reclamation and the colonisation of uncultivated areas to build new agricultural settlements.

Again, a new intensive agriculture at the expense of forestry was the inevitable reaction to the growing demand for food, especially proteins, and, with it, a demand of civilization and progress: from then on, the concepts of natural and wild related with regards to the food industry are relegated to the margins of production and its dominant ideological values. It is the beginning of a big boom, which probably continues to this day. But agrarian expansion brings with it new tensions and social inequalities, conflicts born from the search for fertile lands, duties claims and property

rights, as well as natural disasters, as frequent then as today.

Here the countryside-cities model is born, with all the implications related to the distribution and the storage of food on a large scale. It is a model that ensures stability and the balance of noble protein sources and culminates in the thirteenth century, especially after its progress in agricultural production techniques and more favourable weather climates. This nutritional well-being, the abundance represented by the new wide availability of meat, reaches such a level that even



Agostino Verrocchi, Rome 1585-1659, Oil painting on canvas. Private collection. Modena

the Pope Innocent III feels the need for an indictment against the sin of gluttony and the new delicacies that the insane passion of men has managed to invent.

“Wine, beer, or the good things that come to us from the trees, the earth, the sea, the sky are no longer enough: you want spices and perfumes”.

It is in this century, in fact, that gastronomy is born and its written codification of food recipes, due precisely to the abundance of flavours and gastronomic delights that the cultivation techniques and the expansion of the spice and food markets allowed.

Over the centuries of food abundance meat consumption represents a status symbol, particularly in the fourteenth century, during which there was a reduction in cereal crops in favour of pasture and forage crops.

It is in this period that farms specialised in livestock breeding are born, with its focus on the short and long-range meat trade. It is the so-called carnivorous period of Europe, like the lucky definition that Braudel has accustomed us to call it. A period of happy and individual life, which will last until the XVI century.

The repeated pleas of the ecclesiastical community to eat less, at least in certain periods of the year, more than being a deterrent, indirectly

confirms the centrality of the role of meat in the food system of the time. In modern times, with the emergence of the middle classes and the industrial revolution, meat reaches larger sections of the population. In the wider horizon of a new food democracy, the concept of quality and industry standards were born; with the progress of scientific knowledge, the nutritional properties of meat and its relationship with our health were better associated.

In the past century of efficiency and technology, in a context of even greater food availability, the new model of thinness as the ideal beauty of a powerful body, with perfect productivity, speed

and efficiency is finally imposed; even in this new context, the unstoppable rise in consumption of meat continues, without losing the symbolic value of a conquered dignity to social classes who once were hungry.

And today? Meat is always at the centre of this story of hunger and abundance. Forgotten the famine of the past, we live with abundance and its problems.

In this polarisation between two extremes that have always chased each other in history, today the real challenge is that of moderation and balance. The rediscovery of the original value of the

meat as a good and necessary nourishment and, with it, the word “diet”: a term invented by the ancient Greeks to designate the daily food regimen (but more generally the rule of life): knowledge necessary for a conscious, varied and balanced food consumption, that each individual has to build on their personal needs, attitudes and knowledge of himself. Unlike today, where this word expresses, more superficially, the simple restriction or deprivation of particular foods, often following trends or models imposed by consumer society.

This is the role of meat in the modern diet, a precious and irreplaceable food that finds its rightful place in the Mediterranean Diet, as intended by the wise fathers of our civilisation and not that of some propagators of today, who are more interested in market dynamics rather than our true cultural identity.

3 THE COST FOR CONSUMERS

At a time when the economic crisis is the protagonist of everyday life for businesses and households, we have tried to present a brief insight into the importance of the cost of food in household consumption. It is indeed interesting to note that the proportion spent on food has declined significantly over the past forty years, at the expense of items such as housing or recreation.

In the context of food consumption, meat contributes to about 19-22% of the total monthly “bill” of an average family. In this context it is interesting to look for a relationship between spending and the adoption of “sustainable” diets, such as, for example, the Mediterranean nutritional model. Income levels are indeed often used to determine the quality of life and the type of food eaten.

Many authors⁷ have developed scientific studies in this regard and in this document too, we also decided to present a reinterpretation of the public data in order to provide an additional perspective.

Using the same approach as with the environmental information, the amount of daily food recommended by INRAN (now CREA - Food and Nutrition) has been multiplied by the average prices of individual product categories, as reported for the month of February 2016 by the Observatory for Prices and Tariffs⁸.

The conclusion to which it arrives, which is clearly shown in the “economic hourglass” graphic is one that, by following a diet with the “correct portions”, the meat category does not have higher costs than fruit and vegetables, for which the unit cost is lower, but suggested consumption is greater.



	2015		2016	
MEDIAN MONTHLY EXPENDITURE	€ 2,144		€ 2,141	
AVERAGE MONTHLY EXPENDITURE (=100%)	€ 2,499	%	€ 2,524	%
FOOD PRODUCTS AND NON-ALCOHOLIC DRINKS	€ 441	18%	€ 447	18%
NON-FOOD PRODUCTS	€ 2,057	82%	€ 2,076	82%
ALCOHOLIC DRINKS AND TOBACCO	€44	2%	€ 45	2%
CLOTHING AND FOOTWEAR	€ 116	4%	€ 118	5%
HOUSING, WATER, ELECTRICITY AND OTHER FUELS	€ 902	36%	€ 902	36%
FURNITURE, HOUSEHOLD ARTICLES AND SERVICES	€ 104	4%	€ 107	4%
HEALTH SERVICES AND EXPENSES	€ 113	4%	€ 114	4%
TRANSPORT	€ 266	11%	€ 271	11%
COMMUNICATIONS	€ 63	3%	€ 62	3%
RECREATION, SHOWS AND CULTURE	€ 126	5%	€ 130	5%
EDUCATION	€ 15	0%	€ 15	1%
HOSPITALITY SERVICES AND CATERING	€ 122	5%	€ 128	4%
OTHER GOODS AND SERVICES**	€ 186	8%	€ 183	7%

*Median and average monthly expenditure*** of the sample households. Years 2015-2016, valued in Euro. Source: Istat, 2016*****

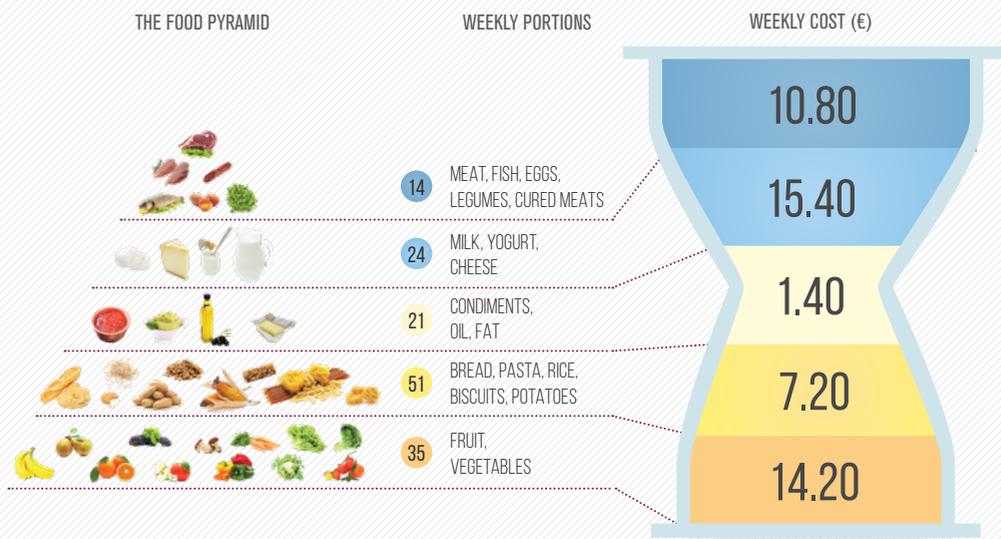
** They include goods and services for personal care, personal effects, social care services

*** The median monthly expenditure is the spending value for consumption that divides the distribution frequency into two equal parts (50% of families have a spending value for consumption that is lower or equal to the median, 50% have a higher value). Since consumer spending has an asymmetrical distribution, the median is always below the average value. The average monthly expenditure, however, is calculated by dividing the total expenditure by the number of families living in Italy.

**** Istat, 2016. year 2016 – The expenditure for household consumption.



THE ECONOMIC HOURLASS



Economic Hourglass expresses the weekly cost of the diet suggested by INRAN guidelines (now CREA - Food and Nutrition), in analogy to what was described for the construction of the environmental hourglass's scenario B (intermediate). The weekly economic expense has been elaborated on the basis of the data provided by the Observatory for Prices and Tariffs, relating to the cities of Turin, Milan, Naples and Palermo, in February 2016.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE ECONOMIC VALUE OF FARMS IN ITALY?

The meat economic sector in Italy generates an economic value in the order of 30 billion Euro per year, compared with about 180 of the entire food sector and to 1,500 of the national GDP. The three main sectors (poultry, cattle and pig) generate an approximately equivalent value.

The differences lie in the analysis of the trade balance: the beef industry imports about 42% of its total requirement, the poultry industry is practically neutral, the cured meat industry is characterised mainly by exports of finished products, but by large importation of fresh pork meat.

In a country that, like Italy, is strongly affected by the effects of the global crisis, the economic role of the production of meat and dairy products on the one hand is the first item in Italian agricultural production, on the other plays an important role in various local economies, which largely contribute to the national total. Livestock farming is also a major source of income in the rest of the world.

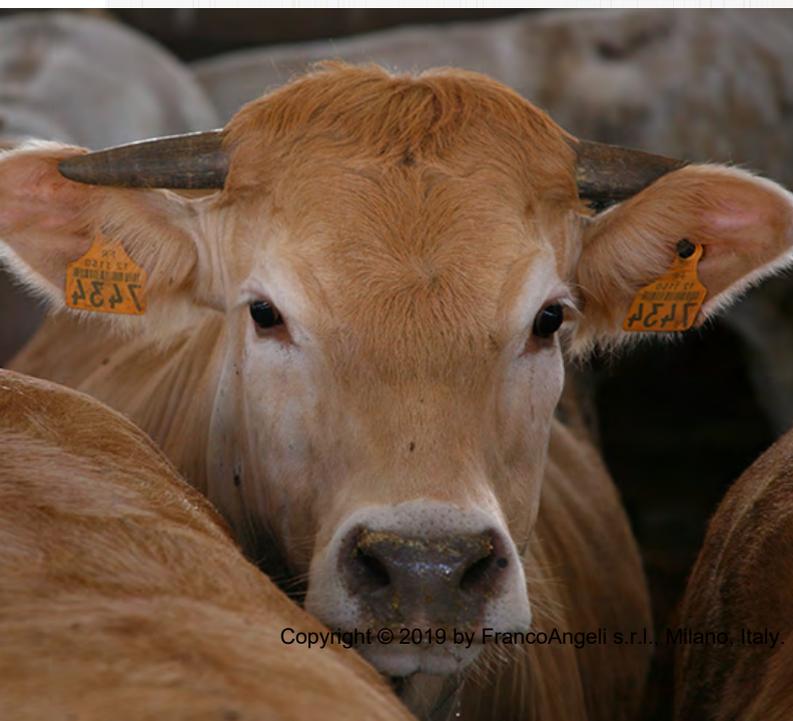
WHY IS MEAT SO EXPENSIVE, COMPARED TO MANY OTHER FOODS?

As part of food consumption, meat contributes to about 19-22% of the total monthly

“bill” of an average family. The meat production chain is complex, and it is necessary to take into account the different aspects, from feed production, farm management, to the slaughter and subsequent meat processing, as well as the distribution and preservation. The presence of these phases, each of which is key, causes the cost of meat to be higher, compared with other foods of the same weight, especially if some foods are more “simple” and characterised by a short production chain.

Meat is more expensive when compared to other foods but this is not true in an absolute sense: take for example poultry, who surely have the best price to quality rapport or the production of beef which has a greater cost because the lifespan of the animal is longer.

Meat generally does not lead to higher costs if consumed according to the amounts suggested by the nutritional guidelines of the Mediterranean Diet, a concept well described by the “economic hourglass” (calculated starting from the same assumptions of the environmental one), which expresses the weekly cost of the diet recommended by INRAN guidelines (now CREA – Food and Nutrition).



NOTES

¹ Starting from the data available on the FAOSTAT website (www.fao.org/faostat/en/#data), were extrapolated data on the number of animals bred by species (bovine, porcine, poultry) used. The filter applied for the extraction is as follows: **Production** > Live Animals – **Regions** > Africa, Americas, Asia, Europe, Italy, Oceania – **Items aggregated** > Cattle and Buffaloes, Pigs, Poultry Birds – **Years** > 1961=2016

² www.ismeamercati.it/carni/carne-bovina

³ www.ismeamercati.it/carni/carne-suina-salumi

⁴ INEA, Report on the State of Agriculture 2013 (www.dspace.crea.gov.it/bitstream/inea/637/1/Rapporto_stato_agricoltura_2013.pdf)

⁵ ISTAT, 6th General Agricultural Census - Atlas of Italian agriculture, 2010. Published in March 2014 ([www.istat.it/it/files/2014/03/Atlante-dellagricoltura-](http://www.istat.it/it/files/2014/03/Atlante-dellagricoltura-italiana.-6%C2%B0-Censimento-generale-dellagricoltura.pdf)

[italiana.-6%C2%B0-Censimento-generale-dellagricoltura.pdf](http://www.istat.it/it/files/2014/03/Atlante-dellagricoltura-italiana.-6%C2%B0-Censimento-generale-dellagricoltura.pdf))

⁶ The agricultural policy (CAP) of the EU (www.europa.eu/pol/agr/index_en.htm)

⁷ Among the most active authors we can remember Drewnowski who in his works, some of them cited in the bibliography, relates the cost of foods, nutritional aspects, income of people and lifestyles

⁸ Goods and Services of Large Consumption, Prices collected for food, fish and fruit and vegetables - February 2016. Last access: May 2016 (www.osservaprezzi.sviluppoeconomico.gov.it/index.php?option=com_content&view=article&id=22:beni-e-servizi-di-largo-consumo&catid=14:livelliprezzi&Itemid=138)

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- Unione Europea: www.europa.eu



FOOD WASTE

-
- 🌱 WHAT IS FOOD WASTE
 - 🌱 WHY AND HOW IS WASTE GENERATED
 - 🌱 HOW MUCH FOOD IS WASTED
 - 🌱 WASTE IN THE MEAT CHAIN

Introduction

IT IS APPROPRIATE TO INTRODUCE THE CONCEPT OF SOCIAL VALUE TO IDENTIFY CORRECTLY FOOD WASTE

THE MEAT SECTOR IS AMONG THE MOST VIRTUOUS, NAMELY ONE WHICH GENERATES THE LEAST WASTE

CONSUMER AWARENESS IS CRITICAL FOR LIMITING WASTE IN THE DOMESTIC CONSUMPTION PHASE

IN THE EU EACH YEAR ABOUT 90 MILLION TONS OF FOOD ARE THROWN AWAY, FOR AN AVERAGE OF 180 KILOS PER PERSON

Source: European Commission (DG ENV), Technical Report-054, 2010 FOOD WASTE

The total amount of food produced worldwide each year amounted to about 4 billion tons, of which an estimated 30%, is lost before consumption. When the weight of the food waste is converted into calories, global food loss reaches **24% of the total production.**

The causes of waste can be found in a combination of effects, which belong both to the world of production, and to that of consumption: from the analysis of the causes, several initiatives aimed at reducing waste were born, with **particular attention to people's education.**

Without losing sight on the ultimate goal of reducing waste, an in-depth analysis of the available information makes it clear that we should avoid trivial errors, such as that of including in the waste both the

actually wasted food and the inevitable non edible waste. A correct interpretation of the concept of waste and its data should take into account the social value of food, separating what is recovered for purposes of human consumption from what instead is recovered as a resource.

In order to try to shed light on these aspects, the data available in the publication "**Feed the hungry**" of the Polytechnic of Milan and the Foundation for Subsidiarity in Italy was analysed, being considered among the most up to date from a scientific point of view. The agri-food chain is divided into several stages which include agricultural and/or industrial operations characterised by different degrees of efficiency and types of losses and waste. Starting with the losses of the primary sector

and the food processing industry, it continues with waste that occurs during distribution, both in collective and commercial catering, up to those of domestic consumption.

The elaboration of the available data shows how the meat sector is amongst those **less subject to the phenomenon of waste, both from the production side and from that of consumption.** Despite the inherently degradable nature of the marketed product, in fact, meat is the sector with the least social waste.

The reasons for this virtuosity are due to the structure and organisation of the supply chain, which allows the processing of by-products in secondary processes, but also the economic, cultural and social value attributed by consumers to these foods.

1 WHAT IS FOOD WASTE

The Commission for Agriculture and Rural Development of the European Commission has defined waste as:

“The quantity of rejected products from the agri-food chain that, for economic or aesthetic reasons, or because of the proximity of the sell-by date, although still edible and therefore potentially usable for human consumption, in the absence of a possible alternative use, are removed and disposed of, producing negative effects in environmental terms, economic costs and lost earnings for companies”¹.

Despite the “official” definition of the European Commission there are many publications which offer different interpretations, leading, as a result, to different estimates of the amount wasted. In the preparation of this document, it was decided to consider the publication “Dar da mangiare agli affamati”² (Feed the hungry), according to which the availability of food, that is, the amount of food produced, has three destinations:

- **HUMAN CONSUMPTION:** component of edible food that reaches people to satisfy their alimentary needs;
- **SCRAPPED FOOD:** inedible components of food that includes the remains of the transformation process, damaged products, broken or sub-quality standards, the inedible parts (bones, fruit stones, etc.);

- **FOOD SURPLUS:** edible part of the food that is produced, processed, transformed and distributed but not sold or consumed. Includes food purchased by the consumer but not consumed.

The excess food can in turn be divided according to how it is managed and its uses:

- **HUMAN NUTRITION:** used to satisfy human needs, through sale in secondary markets, charities, food banks, etc.;
- **ANIMAL FEED:** used to satisfy animal needs, through sale to kennels or zoos, or transferring them to companies dedicated to the production of feed;
- **VALORISED WASTE:** used for the production of fertilisers or the conversion to energy;
- **NON-VALORISED WASTE:** not used and disposed of in landfills.



1.1 Social wastage

According to this classification, it is therefore essential to introduce the social value of uneaten food to the definition of waste, so as to include only the food produced (and therefore edible) that is not used for human nutrition. The inedible parts should not be included in the definition.

For completeness, it is noted that other scholars³ include in the definition of

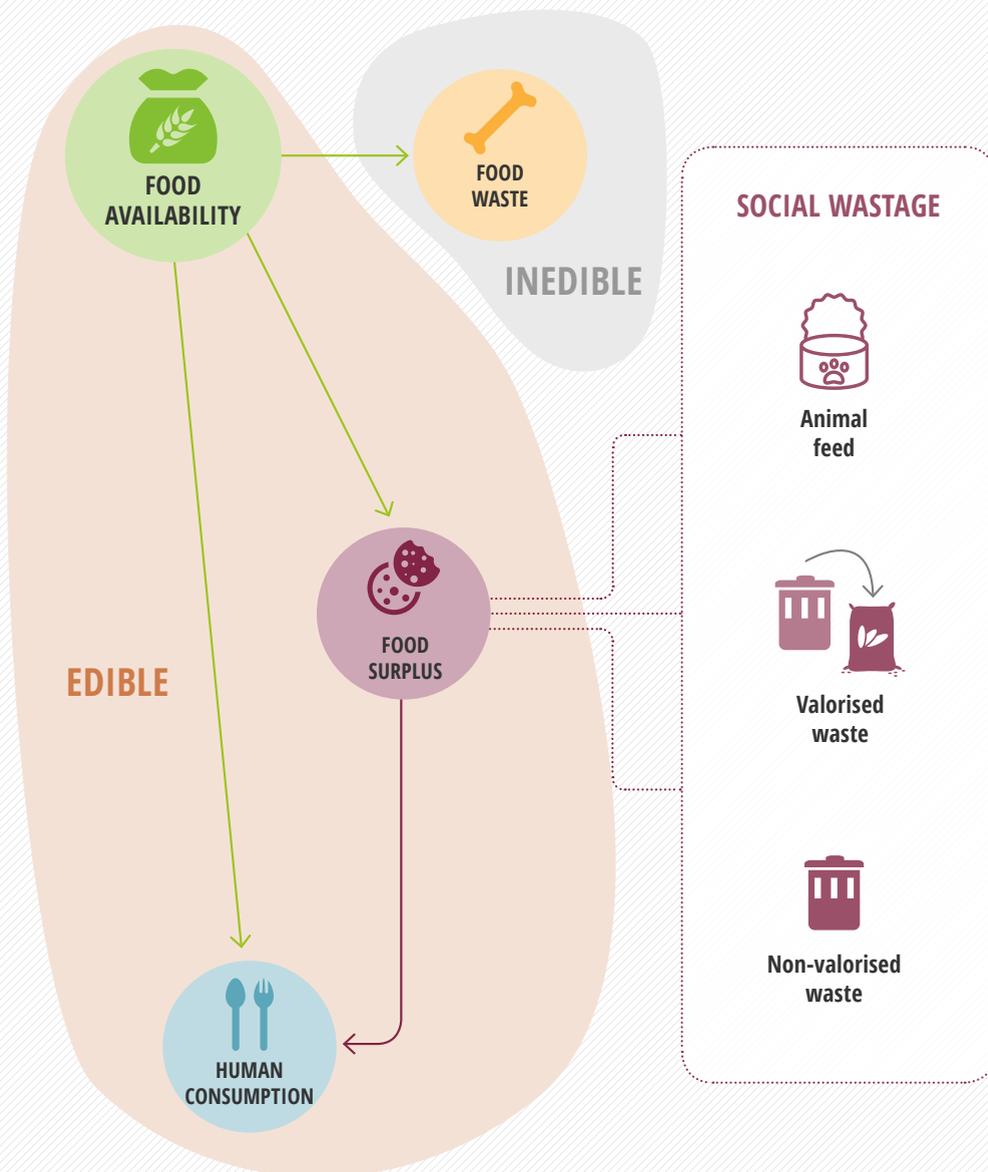
food waste the overfeeding of individuals, which is the difference between the amount of food a person consumes and the quantity really needed according to recommended calories, involving even the overweight and obesity (and resulting pathologies) in the debate.

It was decided not to follow this approach because it is closely tied to nutritional aspects whose in-depth analysis is beyond the scope of this chapter.





SOCIAL WASTE



Food waste includes non-consumed edible food that is not recovered for human consumption

2 WHY AND HOW IS WASTE GENERATED



PRIMARY SECTOR

Includes the phases of growing food and livestock.

In the agricultural phase the greatest losses are caused by the weather or by plant diseases, which cause deviations from the standards required by the market.



TRANSFORMATION

The first and second transformations lead to the creation of food products ready to be placed on the market.

During these phases, the losses are caused mainly by the failure of the product to meet quality requirements and products returned by the market.



Waste can take place during **production** (including distribution), or during **consumption**.

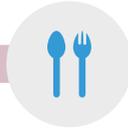
However, it is to be noted that flows considered as waste may have very different destinations; while it is very likely that waste produced during the production and the distribution is intended for animal feed or in any case recycled (e.g. energy as biogas or transformation into compost), it is equally likely that the food wasted during the consumption stages is destined for disposal with significant impacts on the environment.



DISTRIBUTION

The third stage is connected to food distribution, either wholesale or retail.

In this context, much of the waste is due to food remained unsold for reasons related to the quality or consumer preferences.



CATERING

One of the methods of final consumption is represented by the catering sector (collective or commercial) which is becoming increasingly important, given the growing number of meals eaten outside the home.

The waste generated in this phase is due to the non-consumption of the prepared food.



FINAL CONSUMER

In the phase of domestic consumption wastes are mainly due to the over abundance of food bought, inability to consume within the expiry-date or proper food conservation.

// **THE AGRI-FOOD CHAIN IS DIVIDED INTO SEVERAL STAGES WHICH INCLUDE AGRICULTURAL AND INDUSTRIAL OPERATIONS CHARACTERISED BY DIFFERENT TYPES OF LOSSES AND WASTE.**



3

HOW MUCH FOOD IS WASTED

Literature and databases offer a lot of information which is not always comparable due to the different hypothesis that are at the base of the methods of investigation used. In Italy, the first survey on the subject was done in 2011 with the project Last Minute Market⁴ which led to an estimated annual waste of average 27% with an economic value of about Euro 1,700 per family⁵.

In 2012, the aforementioned study of the Milan Polytechnic has led to an estimated waste equal to 16% of consumption. This

second publication is characterised by a greater degree of detail and you can analyse the characteristics of different food categories for the different stages of the supply chain.

The main considerations are:

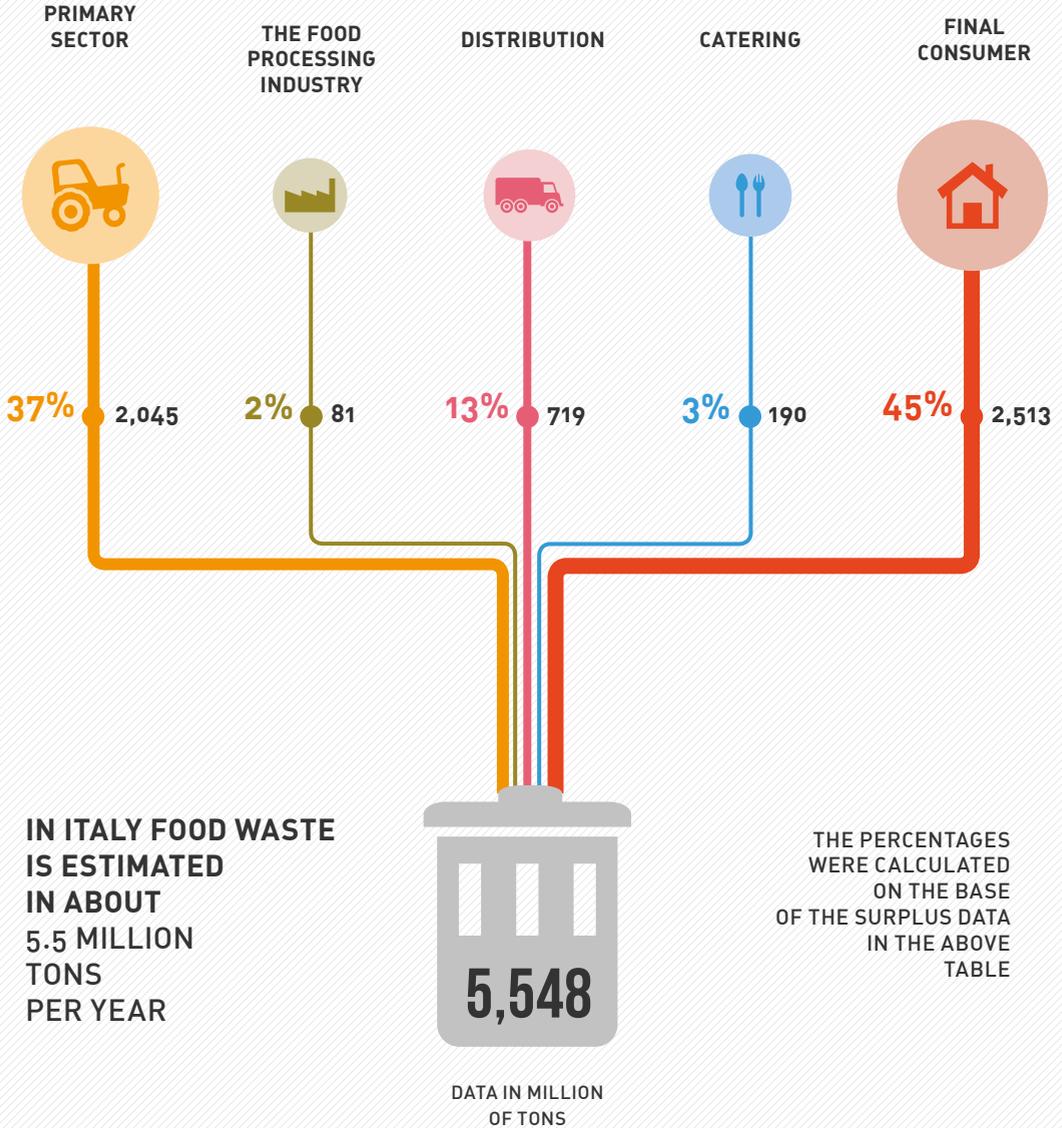
- the stages where you have the greatest wastage are primary production and consumption;
- breeding is among phases characterised by minor social waste in percentage terms.



SEGMENT OF THE FOOD CHAIN		PRODUCTION [1,000T/YEAR]	SURPLUS		
			TOTAL [1,000T/YEAR]	OF WHICH SOCIAL WASTE [1,000T/YEAR]	
PRIMARY SECTOR	Fruit and Vegetables	41,728	2,187.1	1,948.2	89%
	Cereals	22,031	68.1	67.4	99%
	Breeding	14,989	52.5	20.3	39%
	Fishing	475	10.5	9.4	90%
	Total	74,223	2,318.2	2,045.2	88%
TRANSFORMATION	Ambient Temperature	34,641	118.2	36.1	30%
	Fresh	8,553	51.5	33.5	65%
	Frozen	1,592	11.7	11.4	97%
	Total	44,786	181.4	81	45%
DISTRIBUTION	Distributive centres	24,524	73.6	47.8	65%
	Points of sale	30,665	704.0	671.3	95%
	Total	55,189	777.6	719.1	92%
CATERING	Collective	869	86.9	73.8	85%
	Commercial	2,443	122.2	116.1	95%
	Total	3,312	209.1	189.9	91%
FINAL CONSUMPTION	-	31,268	2,513.5	2,513.5	100%
TOTAL	-	213,778	6,000.0	5,548	92%

Summary of the quantitative results of the survey "Feed the hungry" of the Milan Polytechnic. For the main phases of the chain the production, the surplus (i.e. the edible part of the food that is not consumed) and social waste (i.e. the excess not recovered for human consumption) are reported. The data relating to Italy, are reported both in quantity (t/year) and percentage. The surplus is calculated relative to production and waste is calculated relative to surplus. [Source: Garrone, 2012]

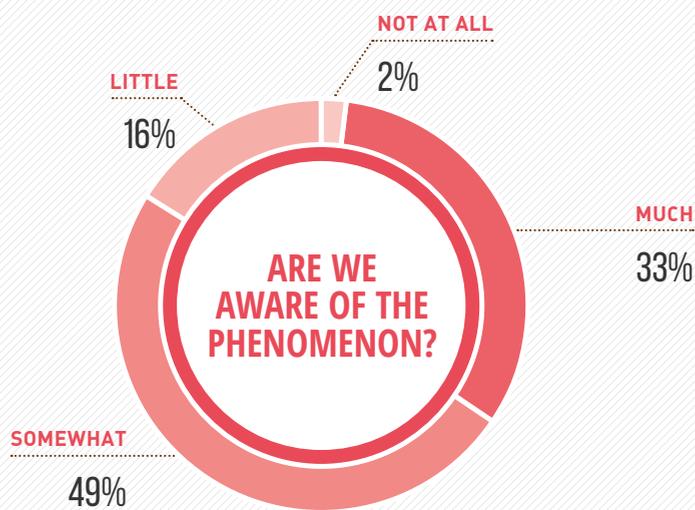
WHO WASTES MORE



Source: processing of data relating to Italy and available in Garrone, 2012



SOME INVESTIGATIONS ON FOOD WASTE

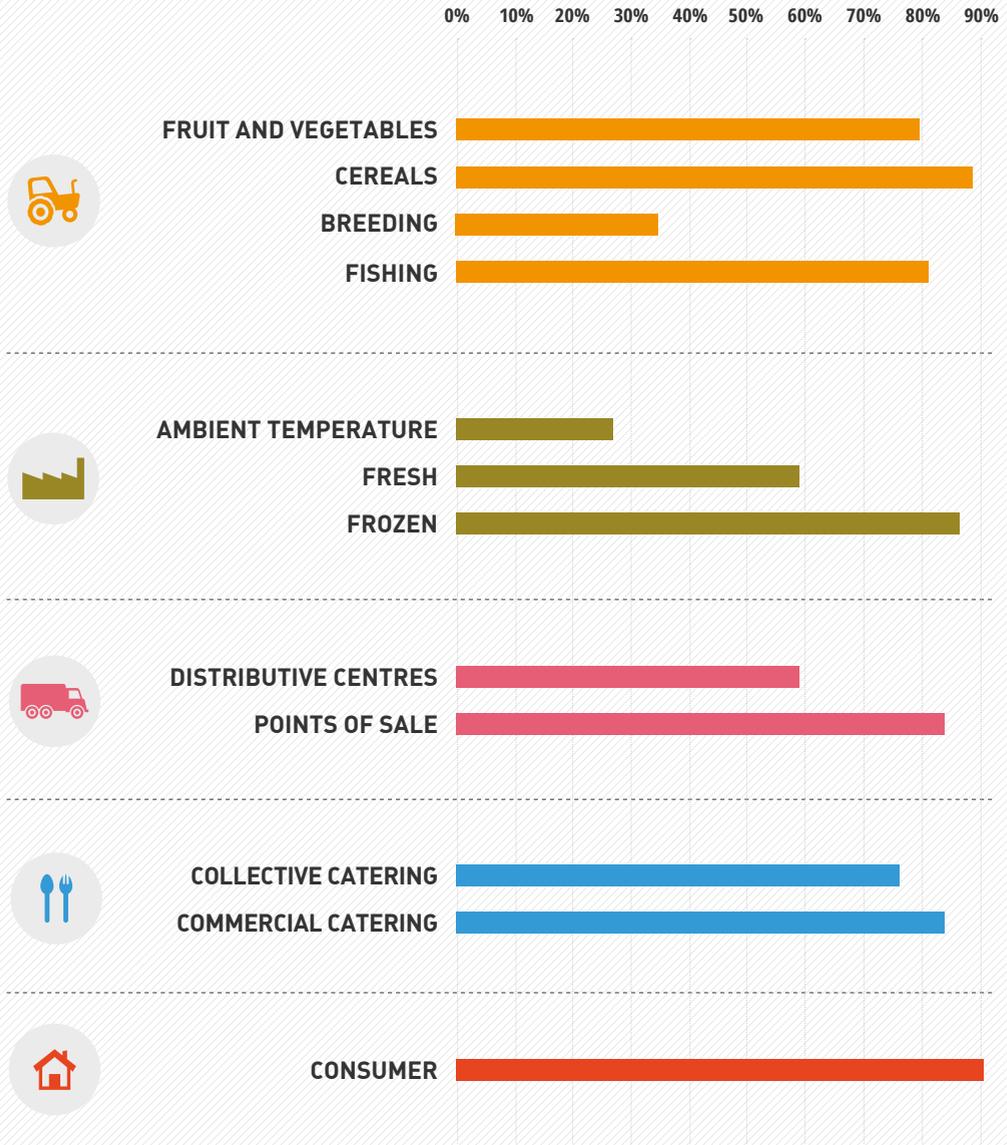


Waste Watcher, since 2013, studies consumer behaviour to investigate the main causes of domestic waste: The main reasons include those relating to the conservation and management of food supplies.
 Source: Report Waste Watcher, 2015





SOCIAL WASTE: REPRESENTS HOW MUCH SURPLUS FOOD IS WASTED



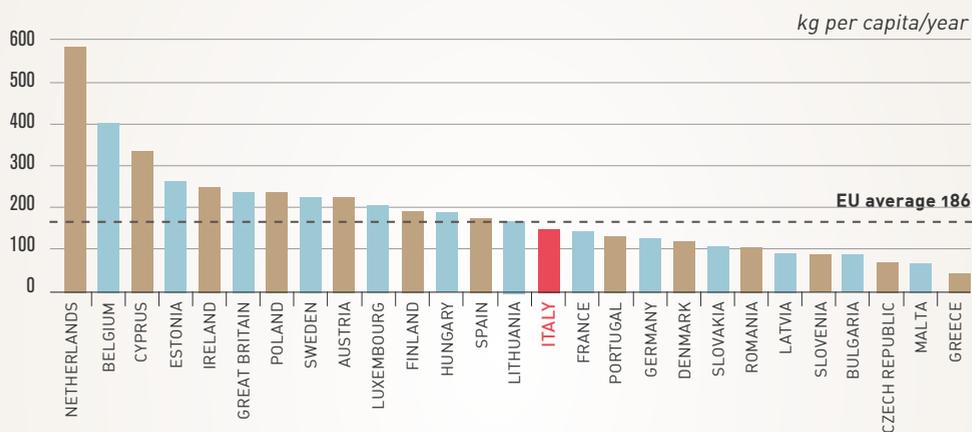
Among the "less wasteful" categories there are foods derived from breeding as well as those included in the "ambient temperature." category (i.e. less perishable) in the transformation chains (Source: Based on data available in Garrone, 2012)

WASTE IN EUROPE AND IN THE WORLD

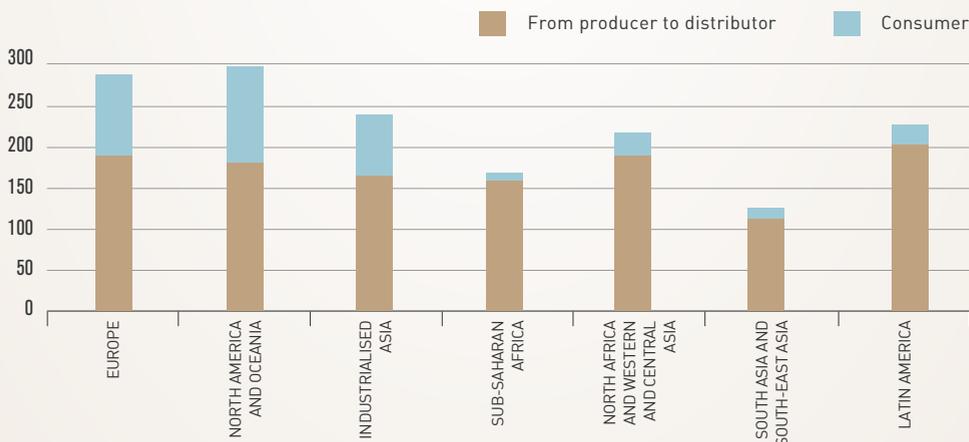
The available data relative to the International situation is difficult to analyse because of the lack of homogeneity in the survey methodology.

Among the various sources available, the European Commission study should be highlighted, that cites a Community waste average of 180

kg of food per capita per year. The data available worldwide, however, shows the differences between developed and developing countries.



Waste in Europe: The data is not strictly comparable since the survey methodologies may vary depending on the country (Source: Eurostat 2006 from Report: European Commission, 2010. Preparatory study on food waste across EU 27. Technical Report – 2010 – 054.

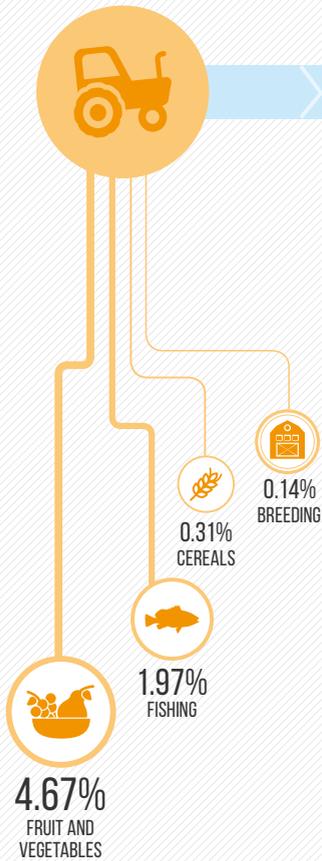


Waste in the world: In addition to the quantity, the main differences concern the breakdown between the various stages of the chain - Source: FAO, 2011

WASTE IN THE FOOD CHAIN

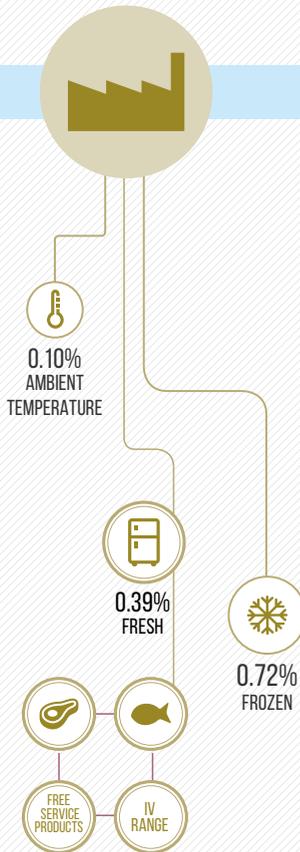
PRIMARY SECTOR

Production: 79,000
Surplus: 2,300
Waste: 2,000



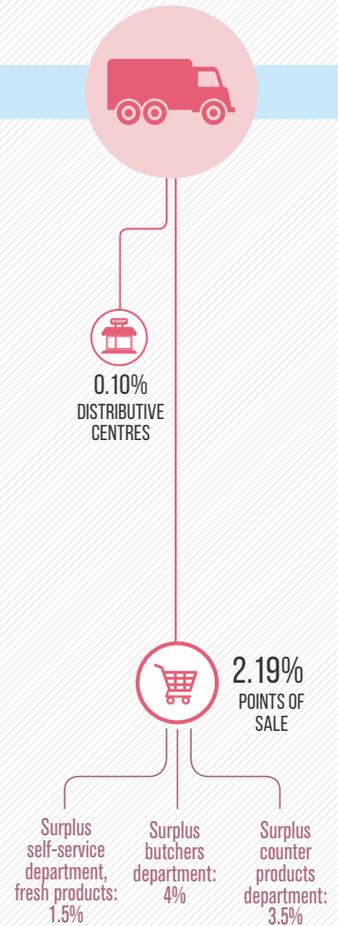
TRANSFORMATION

Production: 45,000
Surplus: 181
Waste: 81



DISTRIBUTION

Production: 55,000
Surplus: 777
Waste: 719





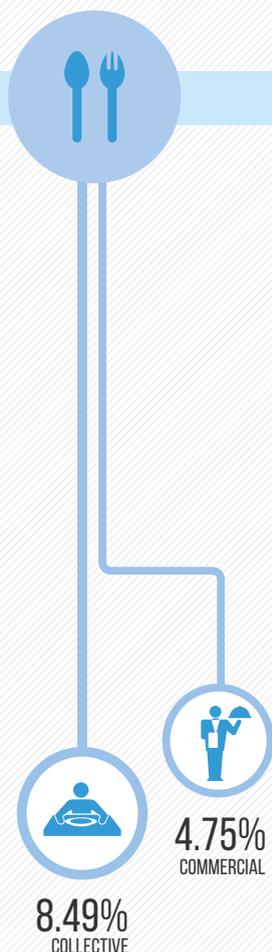
THE PERCENTAGE INDICATES, FOR EVERY STAGE OF THE SUPPLY CHAIN, THE ACTUAL SOCIAL WASTE ON TOTAL PRODUCTION

SURPLUS: edible component of food that is not sold or consumed.

SOCIAL WASTE: part of the surplus that is not used for human nutrition.

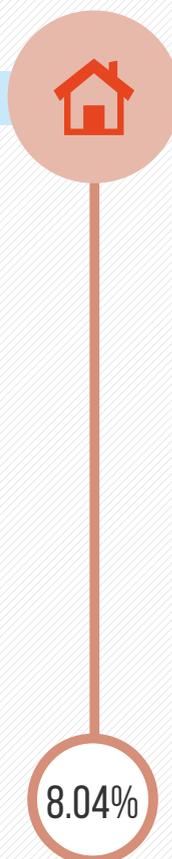
CATERING

Production: 3,000
Surplus: 209
Waste: 190



FINAL CONSUMER

Production: 31,000
Surplus: 2,500
Waste: 2,500



*DATA EXPRESSED IN THOUSANDS OF TONS

4 WASTE IN THE MEAT CHAIN

Among the available and examined data there is no information that allows a precise and definitive figure on wastage in the meat chain. However, a survey conducted by Nielsen in 2011 on a panel of 9,000 Italian families (available in the text cited by Garrone) estimated the incidence of waste by the consumer for each product sector. Starting from the value of food purchases, the volume of food availability was calculated and to this volume were then applied the waste percentages reported by the families. The overall domestic waste of Italian families is estimated to be 2.6 million tons (about 8% of the total purchased).

In this context, the meat and fish chains are among the most virtuous, with a value equal to 5% of the total waste.

The virtuous result is attributable to different factors during the various stages of the supply chain.

During **breeding and primary transformation**, waste is reduced due to the fact that any overproduction of meat from the slaughtering plants are easily preserved using freezing systems.

In the **distribution** phases, the major cause of waste is the reaching of the expiry date which can be controlled with careful order management towards producers. In this stage one must consider that the highly perishable nature of the product causes waste, because reaching the expiry date or having interruptions in

the cooling processes, means that the product no longer meets health and safety standards.

With regards to **domestic consumption**, wastage is reduced because the consumer states that he freezes the food to avoid waste (51%) and stocks less food by shopping frequently without creating too much surplus (49%).

4.1 Meat wastage worldwide

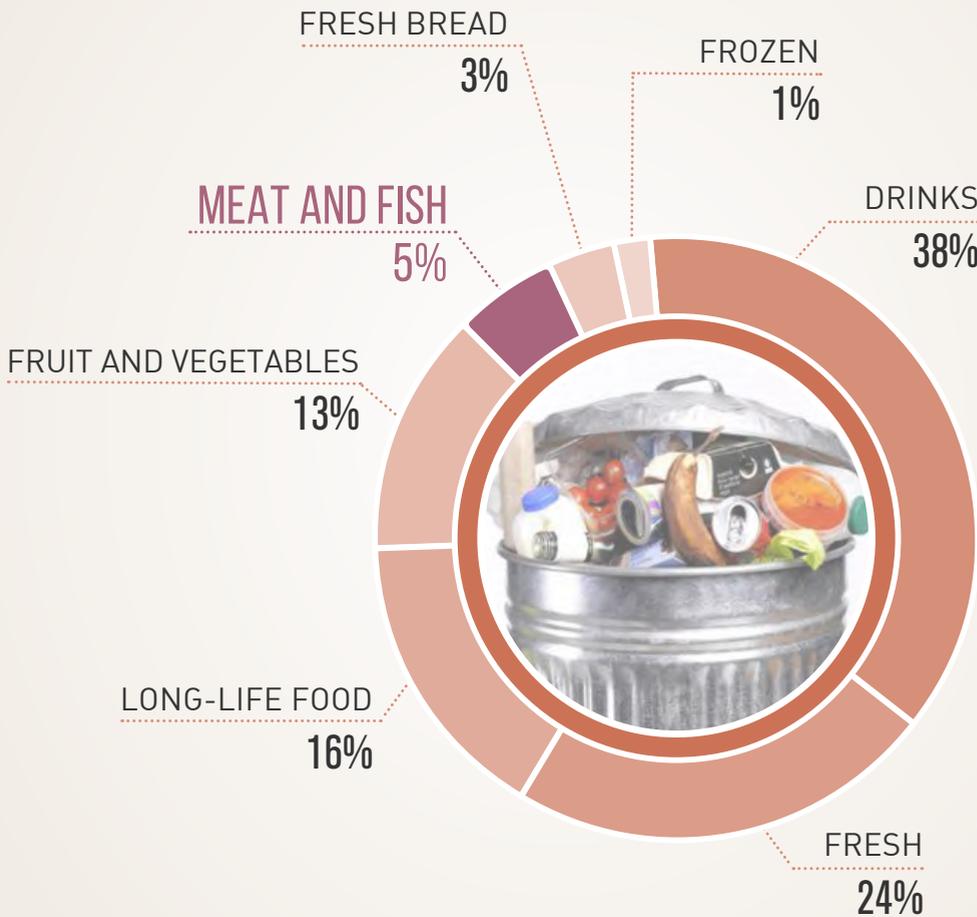
As in Italy, also in the rest of the world the waste of meat is reduced and the differences between the countries are not particularly evident.

However, it is interesting to observe that in industrialised countries the consumer contributes to about 50% of the total waste.

In developing countries losses occur in almost homogeneous amounts throughout the supply chain.

Indeed, in the data on sub-Saharan Africa in the primary sector, losses stand out due to the high animal mortality rate caused by frequent diseases to cattle that are not always properly cured.

BREAKDOWN BY TYPE OF THE TOTAL WASTE OF ITALIAN FAMILIES

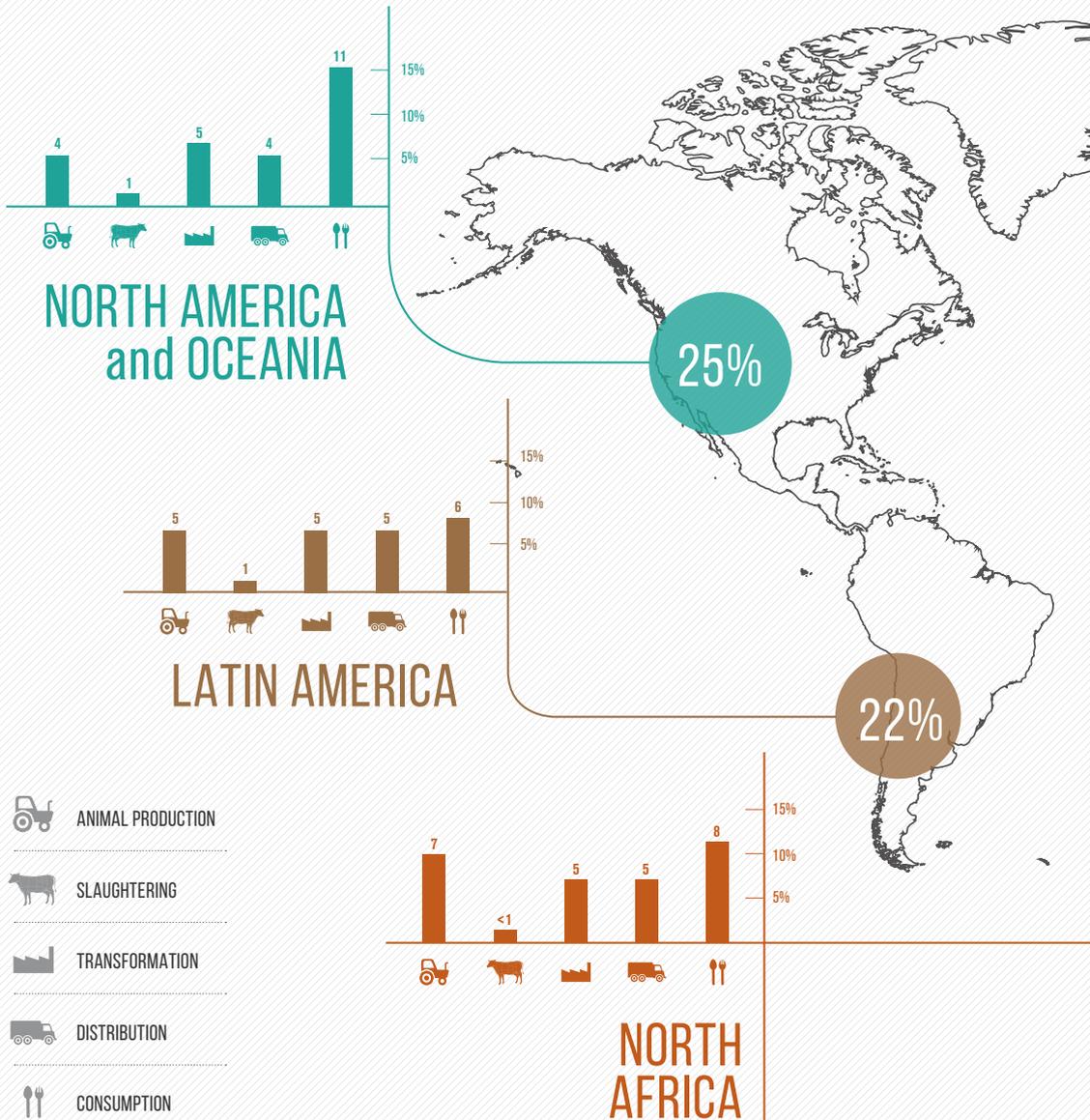


Source: Garrone P. et al., 2012

MEAT WASTAGE WORLDWIDE

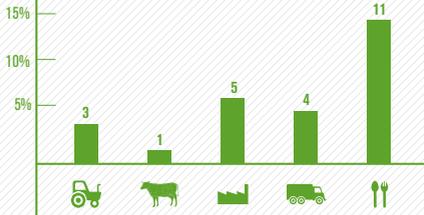
Source: FAO, 2011

IN INDUSTRIALISED COUNTRIES THE CONSUMER CONTRIBUTES TO ABOUT 50% OF THE TOTAL WASTE

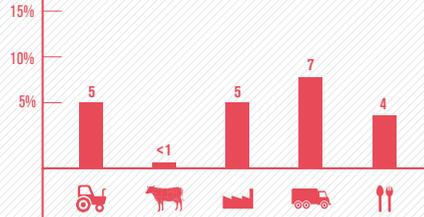




EUROPE



SOUTH ASIA



24%

25%

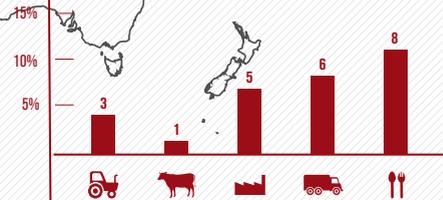
29%

21%

23%



SUB-SAHARIAN AFRICA



INDUSTRIALISED ASIA

FREQUENTLY ASKED QUESTIONS

WHAT DO WE MEAN BY FOOD WASTE?

There are many different definitions of waste. The one used in this document identifies social waste as the amount of edible food that is not used by human consumption. Not considered in the figures are therefore all the “necessary” waste such as banana peels, eggshells or the bones of a steak. Under this definition, it is estimated that the amount of food in Italy wasted to be about 5.5 million tons per year, equal to about 3% of the total quantity produced.

IS THERE A LOT OF WASTE IN THE MEAT CHAIN?

All phases of each food chain, unfortunately, generate waste. Meat, also due to the huge amount of destinations that the by-products have and by reusing livestock waste, slurry and slaughter waste for the production of energy, is in this sense among the most virtuous. The production and consumption of meat, in fact, generates a quantity of less than 50% waste compared to fruits and vegetables, and almost equal to half of the waste produced by the cereal sector. Waste that, despite efforts to reduce the environmental impact of this sector, are mainly due to the final consumption stage.

A fact linked probably to the social and cultural value per-

ceived over centuries for these foods.

HOW CAN WE REDUCE THE MEAT WASTE IN THE KITCHEN?

The least wasted food in the kitchen are those of animal origin, and in particular meat. Moreover, they are those with the highest nutritional value, and those who have always been given the most importance, both socially and culturally. Today like yesterday, therefore, finding ways to avoid throwing away meat is an important skill, for mothers and grandmothers as for the most famous starred chefs. The methods to reduce to zero the waste of this noble food are innumerable.

From valorising the scraps from Festivities or from the day before, simply by heating them, by revising them into new and imaginative recipes or through ingenious simple culinary inventions like meatballs and meatloaf, to avoid wasting meat, cured meats and other products (such as milk and eggs) that remain in the refrigerator is very simple. It takes a little imagination and fantasy.

To promote the culture of “recycling” Carni Sostenibili has recently collaborated with two well-known chefs Massimo Bottura and Lisa Casali whose recipes are described on the portal www.carnisostenibili.it/en



NOTES

¹ Committee on Agriculture and Development Rural - European Parliament, "Avoiding waste of foods: strategies to improve efficiency of the food chain in the EU", 22nd June 2011

² Garrone P. et al., 2012

³ We cite, as an example: Smil, 2004

⁴ Segrè A., Falasconi L., 2011

⁵ The results of the research were published in the report "The black book of waste in Italy: the food", in which it is estimated that, in Italy, levels of waste at home are 17% of the average purchased fruit and vegetables, 15% of fish, 28% of pasta and bread, 29% of eggs, 30% of meat and 32% of dairy products.

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From the mid-1980s, meat consumption in Italy and the western world have stabilised and, in the face of a well-established food security, we have witnessed a changed sensitivity for ethical issues, such as animal welfare and environmental impacts of farms.

The challenge of livestock production has therefore become that of “producing more with less resources”, a challenge at the base of the circular economy, which sets itself the goal of a greater offer, but more “sustainable”, efficient, attentive to the environment and animal welfare, to the fair remuneration of breeders and all those who participate in the creation of value in Italian supply chains.

Analysing the sustainability of meat and cured meats means studying in the most objective way possible different topics concerning both the consumer and the livestock production. This volume presents an interdisciplinary study to describe the “5 faces” of meat sustainability, represented by as many chapters: nutrition, environmental impacts and the circular economy applied to farms and industry, food security and animal welfare, the economic aspects of supply chains and the fight against food waste.

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